

**FINANCIAL STRESS IN THE ASEAN-5 ECONOMIES:  
MACRO-FINANCIAL VULNERABILITIES AND THE ROLE  
OF MONETARY POLICY**

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UNIVERSITY OF MALAYA  
KUALA LUMPUR**

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ROLE OF MONETARY POLICY**

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## ABSTRACT

Using Indonesia, Malaysia, the Philippines, Singapore and Thailand (ASEAN-5) as sample countries, this thesis contributes to the empirical analyses of three gaps in existing literature. The initial analysis addresses a knowledge gap in the measurement of financial stability. Existing measures of financial stability could not simultaneously: (1) reflect stability at a systemic scale; (2) reflect stability with little lag, and (3) incorporate information on the financial structure of the economy. Financial Stress Indices (FSI) are constructed to address these deficiencies. The FSIs are constructed using indicators of stress and weighted using the liability side of the financial structure of the sample economies. The indicators and weights of the FSIs span four major market segments - the equity market, banking system, domestic bond market and foreign finance market. Using data from 1997-2013, the results reveal three periods of higher financial stress. The most severe episode in terms of magnitude and duration was the Asian Financial Crisis (1997-1998). This is followed by the US technology bubble burst (tech bust) (2000-2001) and the recent Global Financial Crisis (GFC) (2007-2009). Interestingly, higher stress levels were seen during the tech bust compared to the GFC in all countries, except Singapore. The FSIs are subsequently modelled as a panel model to investigate the sources of financial stress in the ASEAN-5 economies. The methodology and model specification extends from the Early Warning System (EWS) literature by: (1) including more external variables to better capture the open-economy aspect; (2) including a measure of regional financial contagion; (3) analysing the entire financial cycle instead of just crisis periods, and; (4) using an instrumental variable approach to address endogeneity concerns. The results show that: US financial stress and regional financial contagion are significant common determinants. For country-specific variables, only bank credit emerged as consistently significant. A positive bank credit gap portends higher financial stress. Analysis of the sources of financial stress within individual markets reveals the

importance of the banking system and equity markets for financial stress elsewhere. Country-specific Structural Vector Autoregression (SVAR) models for each ASEAN-5 economy are then estimated to analyse the impact of financial stress on the economy and the relationship between monetary policy and financial stress. The SVAR models are adapted to be suited for small-open economies, by including more external variables and in the model structure, where the external variables affect the domestic variables, but not vice versa. The models incorporate FSIs to reflect financial stress in the global environment and ASEAN-5 economies. The findings show that higher financial stress leads to tighter domestic credit conditions and lower economic activity in all five countries. The impact on the real economy displays an initial rapid decline followed by a gradual dissipation. In Malaysia, the Philippines and Thailand, the central banks reduce policy interest rates (IRs) when financial stress increases, although there is substantial cross-country variation in the magnitude and time dynamics. Lower policy IRs are found to have little significant effects in lowering financial stress, but are still effective in stimulating economic activity through other channels.

## ABSTRAK

Berdasarkan data dari Indonesia, Malaysia, the Philippines, Singapore dan Thailand (ASEAN-5), tesis ini menyumbangkan tiga aspek dari segi analisa empirik yang ditimbulkan dari Kegawatan Ekonomi Sedunia (GFC) pada tahun 2007-2009. Tesis ini bertujuan memberi hasil penyelidikan yang baru dari segi kes ekonomi yang kecil, terutamanya kerana terdapatnya kekurangan tinjauan dalam kajian literatur. Bab 3 memberi tinjauan dari segi ukuran metrik kepada stabiliti kewangan. Indeks Financial Stress dibina (FSI) berdasarkan penunjuk tegangan yang diperolehi dari pemberat dari empat pasaran, iaitu pasaran ekuti, sistem perbankan, pasaran bon domestik dan pasaran kewangan asing. Bab 4 menganggarkan satu model panel berdasarkan FSI untuk mengkaji punca tegangan kewangan dalam ekonomi ASEAN-5 ini. Panel yang ditubuhkan merangkumi kajian sistem 'Early Warning' (EWS) yang dapat memerangkapi sifat empirik yang umum. Keputusan empirik yang umum ini menunjukkan bahawa kedua-dua variabel luaran (KDNK dunia yang lebih tinggi, tegangan kewangan di US, dan penularan kewangan di serantau) serta variabel dalaman (keadaan kredit yang semakin longgar dan aktiviti ekonomi yang bertambah perlahan) menyumbangkan tegangan pasaran kewangan yang lebih tinggi di ekonomi ASEAN-5. Bab 5 menggunakan pendekatan 'structural vector autoregression' (SVAR) untuk menganalisa impak tegangan kewangan dalam ekonomi, serta hubungan di antara tegangan ekonomi dan polisi monetari dalam ekonomi ASEAN-5. Keputusan empirik yang diperolehi mencadangkan bahawa pertambahan dalam tegangan kewangan akan menyebabkan keadaan kredit yang bertambah tegang serta aktiviti ekonomi yang semakin lembab di kelima-lima ekonomi serantau ASEAN. Didapati juga bank pusat dari tiga buah negara utama ini, iaitu Malaysia, the Philippines and Thailand, mempunyai tendensi polisi untuk mengurangkan kadar bunga apabila tegangan kewangan bertambah (walaupun wujudnya perbezaan variasi bersilang dari segi magnitud dan dinamik masa). Polisi kadar bunga

yang lebih rendah didapati tidak memberi sebarang kesan yang signifikan terhadap pengurangan tegangan kewangan. Walau bagaimanapun, polisi bunga a-la rendah ini adalah efektif dalam merangsangkan aktiviti ekonomi dari resesi melalui saluran transmisi yang lain.

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## LIST OF ABBREVIATIONS

AFC	:	Asian Financial Crisis
AIC	:	Akaike Information Criterion
ASEAN-5	:	5 members of the Association of South East Asia Nations (Indonesia, Malaysia, the Philippines, Singapore & Thailand)
BIS	:	Bank for International Settlements
BLR	:	Base Lending Rate
BNM	:	Bank Negara Malaysia
BOT	:	Bank of Thailand
DSGE	:	Dynamic Stochastic General Equilibrium
ECB	:	European Central Bank
EEF	:	Exchange Equalisation Fund
EWI	:	Early Warning Indicator
FOMC	:	Federal Open Market Committee
FSI	:	Financial Stress Index
GARCH	:	Generalised Autoregressive Conditional Heteroskedasticity
GDP	:	Gross Domestic Product
GEM	:	Global Economic Monitor
GFC	:	Global Financial Crisis
HP	:	Hodrick-Prescott
IFS	:	International Financial Statistics
IMF	:	International Monetary Fund
IPI	:	Industrial Production Index
IV	:	Instrumental Variable
LTCM	:	Long Term Capital Management
LIBOR	:	London Interbank Offered Rate

NKM	:	New Keynesian Model
NEER	:	Nominal Effective Exchange Rate
OIS	:	Overnight Indexed Swap
OPR	:	Overnight Policy Rate
PCA	:	Principal Component Analysis
RBC	:	Real Business Cycle
S&P	:	Standard and Poor's
SBI	:	Sertifikat Bank Indonesia (Bank Indonesia Certificates)
SIC	:	Schwartz Information Criterion
SVAR	:	Structural Vector Autoregression
US	:	United States
UK	:	United Kingdom
VAR	:	Vector Autoregression



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## CHAPTER 1 : INTRODUCTION

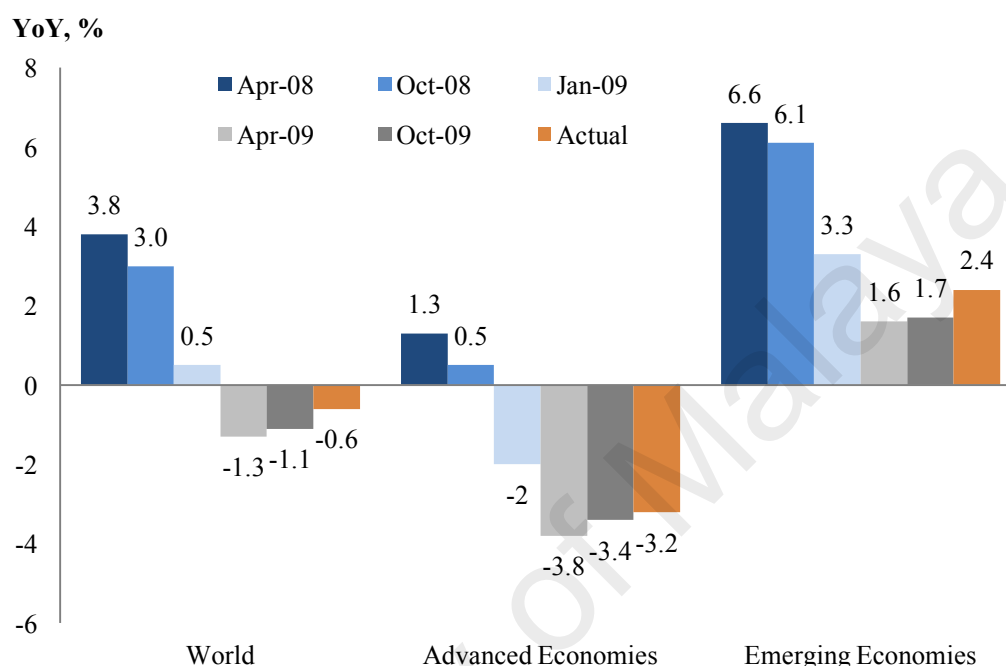
### 1.1 Background

Financial crises are events that demonstrate how interlinked financial markets are with the real economy. Economic contractions are deeper and recoveries take longer during business cycle downturns that are associated with financial crises (Reinhart & Rogoff, 2009, 2014). It is therefore pertinent to have a robust framework to monitor financial stability conditions and knowledge of the available policy options to restore growth and financial stability during crisis periods.

However, financial crisis and financial (in)stability are often seen as binary events in the financial crisis literature. Specifically, the literature on identifying Early Warning Indicators (EWIs) of financial crisis is premised first on viewing financial market conditions as either stable or in crisis, and subsequently identifying the indicators that foreshadow an impending financial crisis. There is an inherent gap in the measurement of financial stability conditions between the states of “no crisis” and “crisis”. It is hence difficult to fully grasp the severity of an impending financial crisis as it starts as an isolated event within a specific asset market to when it becomes a systemic crisis event. Consequently, it is also difficult to comprehend the eventual effects of the crisis on the real economy and, hence, the necessary policy actions to restore macroeconomic stability.

This limitation was highlighted during the Global Financial Crisis (GFC) of 2007-2009. Take for example, the International Monetary Fund’s (IMF’s) outlook for the global economy during this period. Figure 1.1 illustrates that the IMF’s forecast of global growth for 2009 in 2008 was only for a moderate slowdown, but still positive. This was even after Lehmann Brothers investment bank failed in September 2008, which sent the crisis into a substantially more intense phase. When the IMF released their global forecasts the

following month, in October 2008, the scale of the crisis' impact on the real economy was still not yet appreciated. This is seen in the large errors in forecasts made in 2008. It was only in 2009 itself that the agency substantially revised downward growth forecasts that were close to the actual figures.



Source: International Monetary Fund World Economic Outlook (Various Issues)

**Figure 1.1: IMF's Forecast of 2009 Gross Domestic Product Growth**

The main reason for this uncertainty during the GFC and financial crises in general is that there is a lack of high frequency indicators that reflect the escalation of the crisis from its nascent stage, when it is still isolated to individual asset markets to when it becomes a systemic event. This makes it difficult to monitor the progression of the financial crisis in real time. Among the available indicators are individual asset prices and the aggregate balance sheets of economic agents. However, asset prices reflect stress only in specific market segments, while aggregate balance sheet information is often highly lagged since reporting standards only require collection at pre-specified periods at low frequency (e.g. usually quarterly or annually).

In a “crisis” and “no crisis” paradigm, there is a risk that policymakers are jolted into policy action only after a crisis is triggered. In addition, the uncertainty over financial stability conditions cascades to uncertainty in growth forecasts and the formulation of policy responses. This leads to effective policy actions being hampered by a lack of clarity in terms of: (1) whether a change in policy is warranted given the effects that the financial crisis is anticipated to have on macroeconomic stability (growth and inflation), and; (2) uncertainty over the effectiveness of specific policy instruments given the stress in financial markets.

These aspects of policy uncertainty were openly and explicitly expressed by major central banks during the GFC period. The first type of uncertainty is echoed in the European Central Bank’s (ECB) press statement on 2<sup>nd</sup> October 2008, when they decided to leave their monetary policy stance unchanged:

*“...it needs to be stressed that we face an extraordinarily high degree of uncertainty, in large part stemming from the recent intensification of the financial market turmoil. This complicates any assessment of the near to medium-term economic prospects.”* (European Central Bank, 2008)

This judgment reflects the view that as the GFC entered an intense phase (after Lehmann Brother’s failed on 15<sup>th</sup> September 2008), the ECB’s monetary policy consideration was complicated by difficulties in assessing growth prospects due to uncertainties over the impact of the financial crisis. There was thus an indication of policy paralysis that is attributable to the uncertainty over economic prospects.

The second aspect of uncertainty was echoed by the United States (US) Federal Reserve Bank’s Federal Open Market Committee (FOMC) as they deliberated on monetary policy

in 2008 amid the crisis. The following is an excerpt taken from the minutes from the meeting held in October 2008:

*“Some members were concerned that the effectiveness of cuts in the target federal funds rate may have been diminished by the financial dislocations...”* (Board of Governors of the Federal Reserve System, 2008)

Even after the US Federal Reserve Bank began easing monetary policy by this meeting, there was disagreement among members over the effectiveness of the interest rate changes on the real economy, primarily because of different beliefs over changes in the monetary transmission mechanism brought about by the financial crisis.

## **1.2 Research Problem**

As the previous section highlights, there is currently a knowledge gap in the measurement of financial stability conditions on a continuous scale. This drawback in turn limits analyses of other issues that are pertinent for the assessment of macro-financial vulnerabilities and the appropriate monetary policy responses during crisis periods. Specifically, this thesis attempts to address the following three drawbacks in existing literature:

- I. The measurement of financial crises in existing financial crisis studies take on a binary nature - crisis or no crisis. There are two adverse consequences of this approach. First, this measurement approach does not allow the monitoring of financial stability conditions from when stress initially emerges within individual asset markets, to when it becomes a systemic financial crisis. Second, this measurement approach results in studies that do not account for periods that are marked by higher stress in financial markets, but without systemic failures of financial institutions, currency runs or sovereign debt defaults. While not fitting the traditional definition of crises, such episodes are nonetheless significant if they

had large adverse macroeconomic effects (Borio & Lowe, 2002), and hence deserve more attention.

- II. The established empirical commonalities from EWI studies implicitly assumes that crisis periods are different from normal periods, while being silent on the possibility that changes in financial stability conditions may result from large movements in the explanatory variables. While it is relatively clear what the early warning indicators of financial crises are, less clear is what drives the remaining parts of the financial cycle.
- III. The lack of a continuous measure of financial stability has largely constrained time series analysis of the impact of adverse financial shocks on: 1. Economic activity and its transmission mechanism, and: 2. how monetary policy transmission is affected by episodes of financial instability. This is especially true for economies with a low frequency of historical incidences of financial crises.

### **1.3 Research Objectives**

Accordingly, the main objectives of this study are to:

- I. Measure financial stability conditions on a continuous scale. This is achieved by constructing an index called the Financial Stress Index (FSI) that is capable of reflecting financial stress as it emerges from low levels within individual asset markets, to high levels as financial stress spreads across asset markets and become systemic events. This later stage is what current literature often recognises as a financial crisis.
- II. Identify the sources of financial stress throughout the entire financial cycle. This helps to shed light on the factors that determine financial stress beyond just financial crisis periods.

- III. Estimate the dynamic impact of financial stress on the real economy, the transmission channels and how monetary policy effectiveness changes relative to financial stability conditions.

To the extent that there has been a resurgence of interest in these issues especially since the GFC episode, studies that attempt to address them have focused largely on developed economies, where the GFC played centre stage and have eschewed emerging and small-open economies. Undoubtedly, the findings from studies of large developed economies do not automatically apply to emerging and small-open economies. This is because the latter economies tend to have less developed financial markets and different institutions as well as regulatory structures. They also tend to be more vulnerable to sudden reversals in capital flows and external developments. For emerging and small-open economies, a modelling strategy that is distinct from the approach applied on developed economies is hence needed to address the aforementioned issues.

This thesis uses 5 small-open economies from Asia for the empirical analysis - Indonesia, Malaysia, the Philippines, Singapore and Thailand (ASEAN-5). This sample is chosen among the other small-open economies primarily for three reasons. Firstly, the ASEAN-5 economies experienced their own financial crisis over a decade earlier in 1997 and underwent significant structural reforms thereafter in efforts to improve the resilience of its financial markets and economies. When comparing systemic financial stability conditions across time and countries, this event provides a useful benchmark of relative severity and changes in resilience during subsequent financial episodes such as the technology bubble burst in the United States in 2000-2001 and the GFC in 2007-2009. Secondly, these 5 economies possess diverse economic structures. For instance, Singapore is a newly industrialised country with developed and open financial markets, while Malaysia and Indonesia are commodity rich economies who export both food and

fuel. This diversity can help pin down whether the derived empirical findings to the questions posed are country-specific or robust to differences in economic and financial market structures. Finally, as will be shown in subsequent chapters, for the questions posed in this thesis, there is relatively less literature for the selected sample. This is attributable in part to limitations in data availability. There is, in general, less publically available data for emerging economies that span a sufficiently long time period that contains a rich enough set of events to analyse these issues. With the AFC, the technology bubble burst, the recent GFC and subsequent euro debt crisis, the ASEAN-5 economies have recently experienced a sufficiently rich variety of domestic and external financial shocks over the last two decades to facilitate a meaningful analysis of the various facets of financial stability, macro-financial vulnerabilities and how financial stability conditions affect monetary policy transmission.

#### **1.4 Outline of the Thesis**

The remaining chapters are organised as follows:

**Chapter 2** conducts a review of the existing literature. This review sets a historical context of the current state of literature and then traces the evolution of relevant sub-fields to their current stage of development. Finally, the research problems that this thesis attempts to address are highlighted.

In **Chapter 3**, a methodology is developed to measure financial stress on a continuous scale. These measures are presented as indices called, Financial Stress Indices (FSIs), and reflect stress in specific asset markets and at the overall systemic level. Low and high values reflect, respectively, buoyancy and distress in financial markets. The overall FSI for each country is a weighted-average of its market-specific FSIs, with weights that reflect the relative share of financing sourced from the individual market segments. Specifically, the shares reflect the significance of each represented market segment in



providing financing to economic agents. This is done to tailor the FSIs to the differing financial structures across the sample countries and their evolution over time. The FSIs are then used to analyse facets of financial episodes in the region from 1997-2013. This includes the frequency, duration and magnitude of higher stress episodes, and the contribution of stress from individual asset markets to overall financial stress during such episodes. The FSIs provide the basis and starting point for the analyses conducted in chapters 4 and 5.

**Chapter 4** determines the sources of financial stress in the ASEAN-5 economies using a panel data methodology. The panel model is constructed with the FSIs modelled as a function of common global and regional variables, and a set of country-specific vulnerability indicators that EWI studies have traditionally focused on. Two notable contributions are made in this chapter: First, the analysis uses an instrumental variable approach to control for endogeneity arising from two-way causality between financial stress and the domestic variables (e.g. GDP, current account balances, fiscal balances and international reserves). Second, the panel analysis is subsequently conducted on the market-specific FSIs (representing stress in the banking system, equities, foreign exchange and bond market), to investigate if the sources of financial stress are similar across asset markets and to give insight to how financial stress spreads across asset markets.

In **Chapter 5**, the FSIs are embedded in an open-economy Structural Vector Autoregression (SVAR) model for each ASEAN-5 economy to analyse the transmission of financial stress to the real economy and how financial stress affects the transmission of monetary policy. The model structure explicitly incorporates a small-open economy assumption, in which global variables affect the country-specific variables, but not *vice versa*. Impulse response functions from the estimated SVAR models are used to

characterise the speed and depth of the economic downturn in response to adverse financial shocks. This methodology is also utilised to give insight to the roles of credit and the exchange rate in the transmission of financial stress. Finally, impulse response analysis is used to quantify the role of financial stress in altering the transmission of monetary policy to the real economy.

The final chapter, **Chapter 6**, concludes with a summary of the main findings of this thesis. The policy implications are then drawn from the findings especially when viewed from a broader context. This includes areas of policy-oriented surveillance, regional cooperation and the conduct of monetary policy. Finally, the chapter discusses some potentially fruitful avenues for further research going forward.

## CHAPTER 2 : LITERATURE REVIEW

### 2.1 Introduction

The Global Financial Crisis (GFC) of 2007-2009 was, in some aspects, a teachable moment to the limitations of existing macroeconomic models' usefulness for macro-financial surveillance and policy guidance. For central banks, in the two decades or so prior to the GFC, the conduct of monetary policy was guided predominantly through the lens of a "Taylor Rule", in which the policy instrument, usually a short-term interest rate, is modelled as a function of inflation and output. This simplistic paradigm became widely accepted since being introduced because using it for policy guidance seemed to yield successful results as business cycle fluctuations and inflation moderated during the 1980s till the early 2000s. Indeed, many attributed the improved macroeconomic stability to the better management of monetary policies.

Since the GFC, these views have been largely reversed by policymakers and academics alike, and have been articulated particularly forcefully in Blanchflower (2009), Bean, Paustian, Penalver, and Taylor (2010) and Solow (2008). To illustrate, Blanchflower (2009) lamented the following in March 2009 in the midst of the GFC:

*"As a monetary policy maker I have found the 'cutting edge' of current macroeconomic research totally inadequate in helping to resolve the problems we currently face."*

This chapter starts by reviewing the pre-GFC ideology and the limitations to this approach that were highlighted by the GFC episode. The review begins with a brief historical narrative of how macroeconomic models evolved to the state just prior to the GFC episode. The main narrative put forth is that before the GFC, financial markets and financial factors were largely ignored or featured with limited scope in models that were

used for policy analysis. Post-GFC, the debate shifted focus to how to measure these financial factors and how to incorporate them into standard macroeconomic models, so that they can be more useful for surveillance and policy analysis. A sound understanding of the evolution of macroeconomic models from a historical perspective is necessary, as it indicates the directions that were taken in the past that were not fruitful and thus should be avoided going forward.

This literature review then notes the absence of measures of financial instability in mainstream models. It is plausible that its absence may be attributable to the observation that episodes of elevated financial stress are relatively infrequent and hence it was okay to exclude it from the models. However, this perception has largely changed post-GFC. From an analytical perspective, a major hurdle for its exclusion is due to the lack of explicit measures of financial instability. Subsequently, the review traces the progression of three lines of literatures up to their current stage of development. These literatures pertain to: 1. The measurement of financial stability conditions; 2. An explanation of the determinants of financial stability throughout the financial cycle, and; 3. The real economic effects of adverse financial shocks and how monetary policy transmission is affected by financial (in)stability. The limitations in current knowledge are established and are the bases for the analyses in the remainder of this thesis.

The remaining sections proceed as follows: Section 2.2 provides a historical context of how financial factors featured in past macroeconomic models. Section 2.3 discusses the advent of Taylor Rules, its incorporation into models for policy analyses, how it was expanded over time and notes that measures of financial stability were missing from such models. Section 2.4 details the current knowledge on measuring financial stability. Section 2.5 presents the literature that give insight to the sources of financial stability.

Section 2.6 then details the interactions among financial stability, real economic activity and monetary policy. The last section concludes.

## **2.2 A Historical Context of how Financial Factors Feature Models for Monetary Policy Analysis**

### **2.2.1 From Large Scale Models to Monetary Rules**

Before looking at how models should progress in the post-GFC era, it is instructive to first look back at modelling efforts of how financial factors featured in models for monetary policy analysis from a historical context. This is to gain an understanding of what the previous efforts were, how successful they were during that era and why they became outdated.

Among the first frameworks that were developed and used by major central banks for monetary policy analysis were large-scale econometric models such as the MIT-FRB and Brookings models, which were used during the 1960s and 1970s (Brayton, Levin, Lyon, & Williams, 1997). These models consisted of many equations that attempted to account for the various channels through which policy shifts would affect the real economy. For instance, over 60 equations in the MIT-FRB model were constructed and estimated to capture intricate features of the US economy, including the behaviour of the central bank, state and local governments, commercial banks, the household and business sectors and “*a detailed treatment of the financial sector*” (Rasche & Shapiro, 1968). The main goal was to have a detailed analytical framework that was not only capable of quantifying the impact of policy shifts on the real economy, but also how they were transmitted.

These frameworks started to fall out of favour in the mid-1970s for two reasons: Firstly, the simulation results were unstable and forecasts were unrealistic (Gramlich, 2004). Secondly, Lucas (1976) argued that the estimated parameters were not suitable for policy inference. A crucial assumption in these models was that the estimated parameters were invariant to policy changes, for it enabled the conduct of counterfactual simulations to

estimate the impact of hypothetical policy shifts. However, Lucas (1976) pointed out that because firms and consumers were forward looking, their responses would vary systematically with policy shifts. This implied that the estimated fixed coefficients were in fact not fixed, and were thus not valid for policy inference. This line of reasoning is now known as the “Lucas Critique”.

Following the failure of large-scale econometric models in the 1970s, attention then turned to frameworks that advocated a targeted rule-based approach to conduct monetary policy. Though this school of thought, known as monetarism, gained prominence in the 1970s, studies done in the previous two decades provided much of the underlying foundations.

To begin, empirical findings diminished previously held views over the potency of monetary policy, from a multiplier of between four and five to about one (De Long, 2000). Although there was evidence of the short-run non-neutrality of money, it was pointed out that using monetary policy as a stabilisation tool would likely exacerbate instead of smooth economic fluctuations because of the uncertain multiplier and lag effects (Friedman & Shwartz, 1963). These findings supported a rule as opposed to discretion approach to conducting monetary policy.

The monetarist framework gained widespread credibility when the associated researchers correctly predicted that the Phillips curve relationship, a downward sloping curve that characterised a negative correlation between inflation and unemployment, would not hold over the long-run. It was previously thought that a central bank’s decision simply involved conducting monetary policy by deciding among pairs of unemployment and inflation (i.e. a desire to lower the unemployment rate would come at the cost of higher inflation) (Samuelson & Solow, 1960). This was disputed by Phelps (1967) and Friedman (1968), who postulated that the trade-off would only hold in the short-run and that the

long-run Phillips curve was in fact vertical. Their hypothesis implied that repeated attempts to stimulate aggregate demand through expansionary monetary policy would only lead to higher inflation with no decrease in unemployment. This proved correct when the oil price shocks in the 1970s led to both high unemployment and inflation. This event marked a turning point for institutional acceptance of the monetarist framework, as the Federal Reserve and Bank of England adopted fixed targets of the money stock as a policy rule during the mid-late 1970s (De Long, 2000).

### 2.2.2 From Monetary Rules to Interest Rate Rules

However, inflation and unemployment continued to increase in response to the oil price shocks under this new framework of fixed targeting of the money stock. In addition, this policy led to volatile interest rates, which was regarded as detrimental to economic activity and hence unemployment. These events eventually led Paul Volker, then Chairman of the Federal Reserve Bank, to unofficially abandon the monetarist regime in favour of a discretionary approach in 1979 by using the Federal Funds rate (short-term interest rate) as the policy variable. Inflation eventually subsided after the Federal Funds rate was kept high for a sustained period.

Following the failure of the monetarist framework, attention turned to formulating other simple and robust interest rate rules. A key result of this effort was the following expression:

$$i = i^* + \vartheta_{\pi}\pi^* + \vartheta_y y^* \quad (\text{Equation 2.1})$$

$i$  and  $i^*$  are the nominal and natural (equilibrium) interest rate.  $\pi^*$  is the inflation gap (inflation - targeted inflation), and  $y^*$  is the output gap (output - potential output). This rule relates changes in the nominal short-term interest rate to changes in inflation and output. For instance, a nominal interest rate increase is expected to lead to lower inflation and output. Although initially introduced and discussed by (Bryant, Hooper, & Mann,

1993), the formula's applicability for policy was demonstrated clearly by Taylor (1993), when he proposed the following equation using historical data from the United States as a guide:

$$i = 2 + 0.5\pi^* + 0.5y^* \quad (\text{Equation 2.2})$$

This rule came to be known as the “Taylor rule”. The Taylor rule's simplicity in intuition, ease in application and ability to closely fit the historical movements among the Federal Funds Rate, output and inflation in the United States, has since provided a foundation in thinking about the practice of monetary policy globally. Nonetheless, Taylor rules were only single equations which described the output-inflation tradeoff, and were not cohesive macroeconomic frameworks for application by central banks for policy inference. They were also often fitted retrospectively using statistical models and still could not account for structural changes in the economy, thus also making them vulnerable to the Lucas Critique. Since the monetarist regime was abandoned and due to the lack of a better alternative, major central banks such as the Federal Reserve Bank continued using their large-scale macro-econometric models (later ones incorporated versions of the Taylor rule) to forecast and conduct policy simulations. However, they were used as guides without full confidence (Gali & Gertler, 2007).

### **2.3 The Taylor Rule in Macroeconomic Models**

The widespread acceptance of Taylor rules led to renewed efforts to embed it into more complete models that were more useful compared to existing large-scale macro-econometric models for policy analysis. These efforts can be categorised as falling broadly into two main groups, whose progression occurred in parallel with each other: New Keynesian models (NKMs) and Vector Autoregression (VAR) based models.



### 2.3.1 New Keynesian Models

NKMs are Dynamic Stochastic General Equilibrium (DSGE) models and were initially developed in Goodfriend and King (1997) and Clarida, Gali, and Gertler (1999). The core of this framework is its general equilibrium structure similar to that of a Real Business Cycle<sup>1</sup> (RBC) model, thus making it immune to the Lucas Critique. A key point of departure from RBC models is that the introduction of an explicit price setting mechanism and nominal rigidities meant that monetary policy was non-neutral in the short-run and could thus influence aggregate output and prices.

The following key equations emerge from the benchmark model (Clarida *et al.*, 1999):

$$y_t^* = \gamma_0 + \gamma_1(E_t y_{t+1}^*) + \gamma_2(i_t - E_t \pi_{t+1} - i^*) + \varepsilon_{y_t} \quad (\text{Equation 2.3})$$

$$\pi_t = \omega_0 + \omega_1 y_t^* + \omega_2(E_t \pi_{t+1}) + \varepsilon_{\pi_t} \quad (\text{Equation 2.4})$$

$$i_t = \delta_0 + (1 - \rho) \cdot [\delta_1 \pi_t + \delta_2 y_t^*] + \rho \cdot [\delta_3 i_{t-1}] + \varepsilon_{i_t} \quad (\text{Equation 2.5})$$

The residuals  $\varepsilon_{y_t}$ ,  $\varepsilon_{\pi_t}$  and  $\varepsilon_{i_t}$  follow a particular process (often AR(1)) and are interpretable as shocks.  $E$  is expectations,  $y^*$  is the output gap,  $\pi$  is inflation,  $i$  is the nominal interest rate and  $i^*$  is the natural interest rate. Equation 2.3 is interpretable as a dynamic I-S equation. Equation 2.4 is an aggregate supply equation known as the New Keynesian Philips Curve, which differs from its traditional counterpart because inflation here is forward looking and the trade-off is between output and inflation, as opposed to employment as previously formulated. Equation 2.5 is an interest rate rule similar to the Taylor rule.  $\rho$  is a smoothing parameter that ranges from 0 to 1 and reflects the lag effect

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<sup>1</sup> RBC models are DSGE models that attempt to explain business cycle fluctuations. These models posit that business cycles are efficient and generated by technology shocks as opposed to monetary factors, and are equilibrium models in the sense that prices adjust instantly in response to the shocks. This feature of RBC models, that markets always clear, meant there is no role for monetary policy in this framework.

of past interest rate changes. A key feature of NKMs is that the key equilibrium relationships result from dynamic optimisation problems by representative economic agents. The model is then calibrated to the data for policy inference.

The reference model characterised by equations (2.3)-(2.5) has since been extended. Perhaps the most natural extension was to develop an open-economy equivalent (De Paoli, 2009; Galí & Monacelli, 2005), in which the exchange rate, trade, the terms of trade and international financial markets are incorporated. Another extension is to add a backward looking variable for inflation (Gali & Gertler, 1999). This feature incorporates the intuition that economic agents set prices by observing past values. Other features have been added to the reference framework, although the two previously mentioned is the most widely accepted and validated.

### **2.3.2 Vector Autoregression Models**

NKMs are fully specified models based on constructions of utility maximising behaviour of economic agents, which are then calibrated for policy analysis. Vector Autoregression (VAR) models reflect a different approach. Instead of starting with a theoretical model, VAR models start with data and seek to impose as few assumptions as needed to econometrically estimate the macroeconomic relationships.

The main econometric issue in monetary policy analysis is how to account for the endogenous relationships between the policy instrument and inflation and output. Movements in the policy instrument are likely largely influenced by inflation and output, which themselves are also influenced by changes in monetary policy. Hence, simple correlations or reduced form regressions are almost certainly mis-specified and not suitable for statistical inference. Instead, it is necessary to identify “autonomous” monetary policy shocks and estimate how the variables of interest, usually inflation or

output, respond to these shocks. This led to the development of the Vector Autoregression (VAR) methodology.

Pioneered by Sims (1980), the underlying motivation was to reduce the number of restrictions that were necessary to structurally identify the parameters in large-scale macro-econometric models that were prevalent among central banks, such as the previously mentioned MIT-FRB model. His main contention was that a large number of the “*a priori*” restrictions were not sufficiently guided by theory. The following assertion was made in his seminal paper:

*“Many, perhaps most, of the exogenous variables in the FRB-MIT model...are treated as exogenous by default rather than as a result of there being good reason to believe them strictly exogenous. Some are treated as exogenous only because seriously explaining them would require an extensive modelling effort in areas away from the main interests of the model builders.”* (Sims, 1980)

In essence, VARs are multivariate counterparts to AR models. The latter is a single variable model in which it is a function of its lagged values. In comparison, VAR models are multivariate models where each variable is a function of its own lags and those of the other variables in the system. To derive the desired “shocks” that can be used to analyse the effects of policy, it is necessary to place assumptions, most commonly, on the contemporaneous relationships as suggested by Sims (1986), Bernanke (1986) and Blanchard and Watson (1984), or on assumptions of whether the shocks have long- or short-run effects (Blanchard & Quah, 1989). By placing these restrictions to identify the corresponding underlying structural models from the reduced-form VAR models, the resulting models have come to be known as Structural VARs (SVAR).

Many variants of VAR and SVAR models have since been developed. Similar to the progression of NKMs, a line of literature has pursued the development of VAR and SVAR models that are specifically structured for open-economies. These variants have necessitated the inclusion of additional variables that are of high relevance to open-economies, such as the exchange rate, foreign interest rates, the global price level and external demand (in addition to the domestic ones). Selected references of more recent open economy VAR-based models include Cushman and Zha (1997), Kim and Roubini (2000), Genberg (2005) and Maćkowiak (2007).

### **2.3.3 Incorporating Financial Factors into Models with Taylor Rules**

Over time, studies of monetary policy, in particular those that aim to analyse the role of financial markets in the transmission of monetary policy, have gradually incorporated other financial factors into the aforementioned macroeconomic models.

Bernanke and Gertler (1989) and Bernanke, Gertler, and Gilchrist (1999) extend the benchmark New Keynesian Model (NKM) to introduce a feature where the net worth of borrowers and imperfections in credit markets are central in determining output fluctuations and, hence, the behaviour of monetary policy. Within the NKM paradigm, Bernanke and Gertler (1999;2001) and Cecchetti, Genberg, Lipsky and Wadhwani (2000) (CGLW) analyse the potential welfare gains from central bank responses to equity prices. More recently, Christiano, Ilut, Motto & Rostagno (2010) calibrate a NKM and find that there are welfare benefits from expanding the standard Taylor rule to include credit. Cúrdia and Woodford (2010) analyse the welfare benefits of adding credit and credit spreads to the Taylor rule. Simulations from their calibrated NKM indicate that there are welfare benefits from augmenting the Taylor rule to include credit spreads and, to a smaller extent, credit as well. More recent NKM-based studies, especially those after the GFC, also assess the role of housing market interactions on the business cycle and related monetary policy issues (Iacoviello & Neri, 2010; Paries & Notarpietro, 2008).

The development of VAR-based models in incorporating additional features of financial markets has also progressed in similar vein. While the majority of earlier studies on monetary policy analysis were premised on identification schemes around the simplified Taylor rule, it became common for studies to feature a richer presentation of financial markets through the inclusion of money, credit and asset prices (equity and property) in the model. This is reflected in the more recent VAR based studies, for instance, by Morsink and Bayoumi (2001), Bloom (2009), Bean *et al.* (2010) and Raghavan, Athanasopoulos, and Silvapulle (2009), to name a select few.

#### **2.3.4 Financial Stability and Crises in Macroeconomic Models**

Despite these advances in theory and empirical methodologies, one aspect of NKMs, VAR-based models and other macro models that has received insufficient attention is how financial stability conditions and financial crises are measured and integrated into the macro models.

A reflection of the significant consequence of this shortcoming is that the forecasts generated by standard macro models during major financial episodes, such as the GFC, suffer from high forecast errors. This is highlighted in admissions of the inadequacy of existing forecasting methodologies by large institutions such as the OECD (2014), the Federal Reserve Bank and the European Central Bank (Alessi, Ghysels, Onorante, Peach, & Potter, 2014) and the Bank of England (Stockton, 2012) during the GFC episode. In these “post-mortem” studies, the two key attributable factors cited were the failure of macro models to appropriately account for financial market conditions and the size of the feedback loops between financial conditions and the real economy (Alessi *et al.*, 2014).

Another reflection of inadequate incorporation of financial stability conditions in macro models was the lack of guidance on how monetary policy effectiveness was affected by the financial crisis. This led to both sides of the policy divide being taken with a lack of

convincing empirical evidence. For example, Mishkin (2009) argues that monetary policy was effective, indeed more so during crisis periods, because it lowers the chances of adverse feedback loops between deteriorating financial market conditions and real economic activity. In contrast, Bouis, Rawdanowicz, Renne, Watanabe, and Christensen (2013) postulate that monetary stimulus did not provide noticeable improvements to GDP growth because of a breakdown in the credit channel and the decline in the natural interest rate. The lower nominal interest rates from monetary policy easing thus did not translate to higher growth. Bech, Gambacorta, and Kharroubi (2014) also claim that lowering key policy interest rates during financial crises does not lead to higher growth, mainly because of a breakdown in the monetary transmission mechanism. These conclusions are arrived at largely through qualitative argument, reduced-form Taylor rule estimations with constant and time-varying natural interest rates, or pairwise correlations during crises and normal periods.

Thus, before the GFC, there was a relative dearth of efforts to measure financial stability conditions explicitly, analyse how they influence aggregate growth dynamics and, importantly, how higher instability in financial markets affect monetary policy transmission and effectiveness. At best, financial crisis periods, which are special cases of financial stability conditions as it reflects unusually high levels of financial instability, are included as dummy variables. These shortcomings in current knowledge serve as the main motivation for this thesis.

The remainder of this chapter explores three strands of literature to their current stages of development and highlights research opportunities that this thesis attempts to contribute to. A key underlying motivation of this research is to provide insight and tools that policy institutions such as central banks can use for policy guidance and macro-financial surveillance. The first literature explored pertains to how financial stability can be

measured in relatively high frequency (monthly or higher), so that such as indicators can be used to monitor financial stability conditions continuously as crises progress in severity, and from when they initially emerge in individual asset markets to when they become systemic. The second literature explored pertains to current knowledge of what drives financial stability cycles and the identification of early warning signals of impending financial crises. This knowledge informs as to what developments in the real sector and financial markets to monitor closely for financial stability surveillance and crises prevention efforts. The final line of literature that is explored for further development pertains to the macroeconomic effects of changes in financial stability conditions and how monetary policy transmission and effectiveness is affected during periods of financial instability.

## **2.4 Measuring Financial Stability: The Financial Stress Index**

### **2.4.1 The Early Warning Indicators of Financial Crisis**

A precursor to appropriately incorporating financial stability conditions into mainstream macroeconomic models is the measurement of these conditions. The development of Financial Stress Indices (FSIs) reflects these efforts. FSIs were only recently developed, mainly after the GFC, as a complement to the literature on the Early Warning Indicators (EWIs) of financial crises. Broadly, EWI studies focus on predicting the onset of crises and discerning their determinants. However, they often treat the crisis variable as binary events - crisis or no crisis - and were concerned mainly with specific types of crises, such as balance of payments, sovereign debt or bank crises (Borio & Drehmann, 2009; Illing & Liu, 2006). This ignored historical evidence that financial crises often involved more than one market, which Laeven and Valencia (2008) find to be an unreasonable assumption<sup>2</sup>. For instance, the authors categorise financial crises as banking, currency or

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<sup>2</sup> An except is Kaminsky and Reinhart (1999), as they analyse the interactions between balance of payments and banking crises.

sovereign debt crisis and find that 42% of banking crises from 1970-2007 involved a crisis in at least one other category. Thus, though informative, the EWI literature was unhelpful for gauging the relative intensity of crises in the overall financial system, while incidents that were isolated to securities markets were often ignored. In addition, “near miss” episodes, when the degree of financial stress was not severe enough to be classified as crises, but were nonetheless widely acknowledged to have had macroeconomic consequences, are often ignored in this line of inquiry (Borio & Lowe, 2002).

#### **2.4.2 Current Financial Stress Indexes**

The development of FSIs reflects an attempt to address these limitations, especially after the GFC period. They are composite indices constructed from asset prices, which provide a synthetic measure of stress across the entire financial system and within specific asset markets. FSIs complement the EWI literature in that they can be used to identify incidences of financial crises, by defining crises as periods when the FSIs exceed pre-determined thresholds. The markets that are covered in existing FSIs vary across studies, but often encompass the equity market, bond market, banking sector and foreign exchange market. Influential studies that construct FSIs are Illing and Liu (2006) for Canada, Hakkio and Keeton (2009) for the United States, Cardarelli, Elekdag, and Lall (2011) and Melvin and Taylor (2009) for 17 advanced economies and Balakrishnan, Danninger, Elekdag, and Tytell (2011) for 26 emerging economies. More have since been developed in other papers, for instance, by Yiu, Ho, and Jin (2010), Duca and Peltonen (2011), Tng, Kwek, and Sheng (2012) and Park and Mercado Jr (2014)<sup>3</sup>.

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<sup>3</sup> Existing FSI studies have focused primarily on the empirical methodology to construct their respective indices. There is nonetheless an interpretation about the causes and consequences of movements in the FSI that can be drawn from asset pricing and macro-finance theories. The link to asset price theory stems from the fact that FSIs are constructed from asset prices. Conceptually, the price of a financial asset corresponds to the expected discounted payoff that the asset is expected to generate over time. In this formulation of the asset price, the discount factor is dependent on the risk-free rate of return and the risk premium of the asset. Importantly, the risk premium reflects aggregate macroeconomic risks that imply a correlation between asset prices and the business cycle – riskier assets have a higher tendency to perform badly amidst adverse macroeconomic conditions. Indeed, financial assets (whose prices are often referred to as the “marginal value of wealth”) play crucial roles in the interpretation of key equilibrium conditions in dynamic macroeconomic models, such as the savings investment equation, the marginal rates of substitution to the marginal rate of



Constructing the index involves decisions of which variables and weighting method to use. The choice of variables depends on the characteristics of financial markets specific to the country of interest. Balakrishnan *et al.* (2011) points out that emerging markets tend to be susceptible to volatile currency movements from swings in capital flows, and thus pay more attention to reflect this aspect of stress by including a variable constructed from the exchange rate and foreign reserves in their emerging market FSIs. Meanwhile, Cardarelli *et al.* (2011) and Hakkio and Keaton (2009) include more securities market variables such as corporate bond spreads in their advanced economy FSIs.

As for the weighting methods, there are three main options. The first and most popular is the variance-equal weights approach adopted from the currency crisis literature. This method is applied in Cardarelli *et al.* (2011), Melvin and Taylor (2009) and Balakrishnan *et al.* (2011). Here, the variables are standardised and added to obtain the overall FSI. This approach equalises the volatilities and weights of all the variables to prevent individual variables from dominating variation in the overall FSI. The second method derives weights by conducting principal component analysis on the variables. This is applied in Hakkio and Keaton's (2009) FSI for the United States. This method involves deriving the weights such that the FSI accounts for as much of the total variation in the individual variables as possible. This implicitly assumes that financial stress is the common factor driving the co-movement among all the variables in the index. The final weighting method, suggested by Illing and Liu (2006), involves assigning weights that are proportionate to the size of financing of the stress measure's representative markets. This approach is the most appealing as it establishes a direct link between financial stress

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transformation condition and how consumption and investment is allocated across time and states (Cochrane, 2005). In what follows in the remainder of this chapter and thesis, the review of existing studies and related discussions pertaining to the causes, linkages and consequences of financial stress are premised upon the concept that higher macroeconomic risk is associated with higher financial stress. A comprehensive review of these theoretical foundations and related discussions from the macro-finance literature can be found in Cochrane (2005), Cochrane (2008) and Cochrane (2016).

and the financial structure of the economy. For example, in this weighting scheme, financial stress in an economy where financing is dominated by bank credit is more sensitive to bank specific shocks relative to other shocks. Table 2.1 presents a summary of the variables, weighting schemes and samples in selected influential studies.

#### **2.4.3 Building on Existing FSIs for ASEAN-5 Economies**

Chapter 3 constructs FSIs for the ASEAN-5 economies of Indonesia, Malaysia, the Philippines, Singapore and Thailand from 2007-20013. While this sample has already been covered in existing studies, for instance by Balakrishnan *et al.* (2011) and Park and Mercado Jr (2014), there are contributions in the methodology. First, these studies have not explicitly measured stress in domestic debt markets, with the closest related coverage being stress in the sovereign debt market. Second, existing ASEAN-5 studies weight their indicators to construct the overall systemic FSI using either equal variance weights or through Principal Component Analysis (PCA). These weighting methodologies are not derived based on the characteristics of the sample economies' real sector or financial markets. Having variance equal weights prevents movements by any individual indicator from dominating movements in the aggregate index, while the intuition from PCA-based indices are premised on an unobserved common factor that underpin the associated linear combination of the individual variables that capture the highest variation among the variables. The latter case is normally justified on the basis of herd behavior in markets and financial contagion, instead of economic fundamentals. Importantly, none of the FSIs have applied the most economically intuitive weighting method of constructing weights based on the financial structure of the economy. That is, the indicators that reflect stress in markets of larger significance in providing financing to the economic agents are given proportionately larger weights. These issues are discussed in detail in Chapter 3.

**Table 2.1: Summary of FSIs from Early Studies**

Study	Variables	Weighting Scheme	Sample Country
Illing and Liu <sup>4</sup> (2006)	Banking sector beta, exchange rate volatility-loss (CMAX), covered Canada-U.S 90-day treasury spread, bid-ask spread on 90-day Canadian treasury bills, inverted term spread (average of 5 and 10-yr minus 90 day), stock market volatility-loss (CMAX)	Credit, variance equal, principal component	Canada
Balakrishnan, Danninger, Elekdag and Tytell (2011)	Banking sector beta, TED-spread (3-month labor minus 3-month treasury yield), inverted term spread, corporate bond spread, stock market returns (year-on-year change), stock market volatility (GARCH), real exchange rate volatility (m-o-m percent change)	Variance equal	17 advanced countries
Cardarelli, Elekdag and Lall (2010)	Banking Sector beta, stock market returns (y-o-y change), stock market volatility (GARCH), sovereign debt spread, exchange market pressure index (changes in exchange rate and reserves)	Variance equal	27 emerging countries
Hakkio and Keaton (2009)	TED-spread, 2-year swap spread, off-the-run/on-the-run 10-yr spread, Aaa/10-yr treasury spread, Baa/Aaa spread, high-yield bond/Baa spread, Consumer ABS/5-yr treasury spread, Negative value of correlation between stock and treasury returns, Implied volatility of overall stock prices (VIX), idiosyncratic volatility of bank stock prices, cross-dispersion of bank stock returns	Principal component	United States
Melvin and Taylor (2009)	Banking sector beta, TED spread, inverted term spread, corporate bond spread, time varying stock volatility, time varying real exchange rate volatility	Variance equal	17 advanced economies

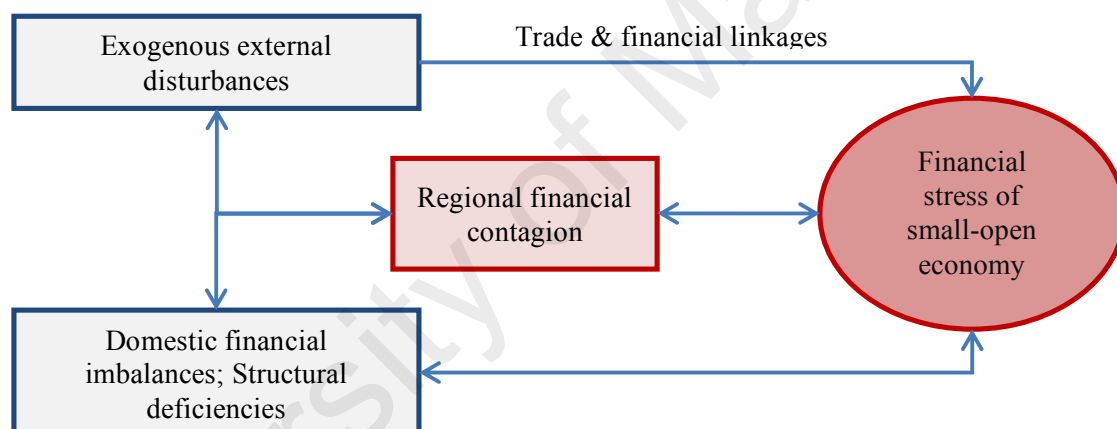
<sup>4</sup> The authors consider many variants for similar variables in their study. The ones listed are from their selected best performing variant, the “standard-variable credit-weighted” index.

## 2.5 The Sources of Financial Stress

For policy institutions that utilise indices such as the FSIs for macroeconomic level surveillance of financial markets, a natural question that arises is “what drives movements in the FSI”. Put differently, what are the determinants underlying the changes in financial stability conditions.

### 2.5.1 Early Warning Indicators of Financial Crisis

Figure 2.1 presents a schematic of the factors that can cause movements in financial stress in open economies.



**Figure 2.1: Schematic of the Determinants of Financial Stress**

First, accumulated financial imbalances and structural vulnerabilities in the domestic economy tend to be precursors of financial crisis. Typical signs of such imbalances and vulnerabilities include high leverage, high asset prices, larger current account deficits, larger capital inflows and overvalued exchange rates<sup>5</sup>. A key finding is that financial

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<sup>5</sup> Early influential studies in this strand include B Eichengreen, Rose, Wyplosz, Dumas, and Weber (1995) and, Kaminsky, Lizondo, and Reinhart (1998), Kaminsky and Reinhart (1999) and Borio and Lowe (2002, 2004). See Frankel and Saravelos (2012) and Gourinchas and Obstfeld (2012) for recent discussions and further references on the early warning literature. Alessi and Detken (2011) is an exception as they also include global measures of liquidity in their assessment of early warning indicators.

crises have a higher probability of occurring just after the boom phase of the business cycle against the backdrop of worsening macroeconomic fundamentals, with credit/monetary conditions looser on the eve of crises. A typical scenario depicts an overheating real economy financed by foreign credit and capital (portfolio and direct investment) inflows, as well as high domestic credit and asset prices during the boom phase. Real economic activity subsequently peaks and starts to moderate. An event then triggers a “sudden stop” in capital inflows causing the current account deficit to be unsustainable. This development, together with a credit crunch in domestic financial institutions and falling asset prices, causes real economic activity to slow substantially, usually due to a large prolonged investment slump to restore the internal-external balance<sup>6</sup>.

### **2.5.2 Spillovers from External Financial Episodes**

In addition to domestic financial imbalances, financial cycles in small-open economies, such as the sample used in this thesis, are also influenced by external developments especially from major financial centres. In cases when financial shocks originate externally, the degree of spillover to other markets depends in part on trade and financial linkages between the economies<sup>7</sup>. A higher integration to the origin of the financial shock potentially increases the degree of stress transmission. Financial spillovers can also occur from non-fundamental reasons, such as herd behaviour among market participants.

#### **2.5.2.1 Trade Linkages**

The trade channel in driving financial spillovers has been extensively studied in existing literature. Chui, Hall, and Taylor (2004) and Balakrishnan *et al.* (2011) note that when

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<sup>6</sup> See Reinhart and Tashiro (2013) for a discussion of the role of investment as an adjustment mechanism and its prolonged drag post-financial crisis. See Calvo (1998) for an initial detailed description of sudden stops.

<sup>7</sup> See Cheung, Tam, and Szeto (2009) for a review of the contagion literature.

trade shocks occur, the spillover effects in financial markets can occur before the real economy effects are visible. This is because the financial market effects reflect changing expectations by market participants of the real economy effects, while the direct effect of lower trade on growth occurs with a lag. The trade channel operates in two ways: First, an adverse external demand shock reduces the external economy's income, which lowers its import demand and hence adversely affects its trade partners. Second, the trade channel may operate indirectly through competition with common export markets. For example, an exchange rate depreciation increases the economy's export competitiveness relative to its competing exporters to common export destinations. Barry Eichengreen, Rose, and Wyplosz (1996), Glick and Rose (1999), Forbes (2002) and Forbes (2004) find the significance for direct and indirect trade linkages.

#### **2.5.2.2 Financial Linkages**

Financial spillovers may also occur through linkages in financial markets, of which there are three major channels - bank, portfolio and direct investment. Essentially, a financial crisis in an economy causes a reduction in the supply of credit and capital to its destination economies. Garber and Grilli (1989), Valdes (1997) and Allen and Gale (2000) analyse international financial spillovers when financial institutions (e.g. banks and hedge funds) face liquidity shortages during crises. In efforts to raise liquidity within a short time span, many financial institutions are forced to sell assets from other countries at the same time. This triggers capital outflows in both portfolio securities and direct investments, and depresses asset prices and economic activity in the host countries. Similarly, banks facing crises are likely to reduce their exposures to higher risk loans, including loans to other countries. Another channel is through portfolio rebalancing by financial market participants where funds, especially leveraged funds, sell assets from other markets to raise liquidity to meet margin calls if the value of their collateral is sufficiently adversely

affected. In these scenarios, the participants often choose to reduce their portfolio risk exposures to emerging economies.

### **2.5.2.3 Other Explanations**

Although trade and financial linkages have been studied extensively, they are insufficient to fully explain the propensity for financial crises to spread, as crises often trigger crises elsewhere despite weak trade and financial linkages (Cheung *et al.*, 2009). For instance, Rose and Spiegel (2011) focus on the recent GFC episode and fail to find systematic evidence that trade and financial linkages between the US economy, the origin of the GFC, and other economies explain how the crisis spread from the US to elsewhere.

One explanation is that in addition to trade and financial linkages, financial spillovers also result from behavioural aspects among financial market participants. In an environment of asymmetric information in which some investors possess more private information than others, it is optimal for less informed investors to follow those who are perceived to be better informed. The process in which expectations formation changes during the buildup of a financial crisis, when an increasing number of less informed investors start following a few “better informed” economic agents gives rise to herd behaviour in financial markets.

The dynamics of financial spillovers arising from herd behaviour is perhaps best analysed through the lens of financial networks. This theory views financial markets as a vast and complex network, with individual institutions and markets connected at the regional and global scale. Haldane (2009) describes 3 properties of financial networks and their implications for financial stability: First, the health of the overall network, or systemic financial stability, exhibits a tipping point property that makes the system robust yet fragile. Risk in financial markets are adequately diversified when the level of connectivity between nodes of the network are below a threshold. When the level of connectivity

increases above the threshold, the impact of financial shocks is transmitted across nodes with positive feedback. In addition, the probability of adverse second round effects of the initial shock increases, thus threatening to set off a vicious cycle of stress transmission within the network. This causes eventual losses that are disproportionately large compared to the size of the initial shock. These dynamics are uncovered in the banking sector in simulation exercises conducted by Gai and Kapadia (2010). The second property is that the health of financial networks is robust to “random” shocks, but susceptible to targeted attacks. Finally, nodes within networks are organised into clusters, with key nodes within clusters that are connected to other clusters.

Several implications emerge from these properties when ASEAN-5 financial markets are viewed as a cluster (henceforth, ASEAN cluster) within the global financial network<sup>8</sup>. The first is that the size of financial shocks and their origin (whether they originate from within or outside the cluster) are not the only determinants of the health of the ASEAN cluster. It also matters whether the cluster’s nodes are subjected to repeated adverse shocks, or targeted attacks. Furthermore, shocks that originate from outside the cluster are transmitted to the region through countries and asset markets that are most connected to the source of the shock.

These implications seem to match the ASEAN-5 economies’ recent experiences in financial markets. Though the trigger of the AFC was arguably smaller than the GFC<sup>9</sup>, financial crises databases (for example, by Laeven and Valencia (2008)) indicate that there was substantially more instability in ASEAN-5 financial markets during the AFC.

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<sup>8</sup> Besides geographical similarities, this cluster is justified on grounds that the countries comprise a trading bloc via the ASEAN Free Trade Agreement (AFTA).

<sup>9</sup> Commonly agreed on triggers for the Asian Crisis and Global Crisis are, respectively, the devaluation of the Thai Baht and collapse of Lehman Brothers in the US.



This is likely because subsequent financial shocks during the AFC were targeted to nodes within the ASEAN cluster, whereas shocks during the GFC occurred outside the cluster and were not targeted directly to ASEAN financial markets.

### **2.5.3 Regional Contagion**

The presence of herd behaviour and financial networks suggest strongly that financial stress can manifest through contagion at the regional level. Park and Mercado Jr (2014) find significant regional effects in the transmission of financial stress in emerging economies. This may be attributable to the regional economies sharing common creditors or being viewed as having similar macroeconomic risk profiles. Thus, shocks that trigger deleveraging by financial institutions, asset sell-offs and portfolio rebalancing by funds have regional, as opposed to country-specific effects. Kaminsky, Reinhart, and Végh (2003) and Kaminsky and Reinhart (2000) study the financial crises in Latin American and Asian economies during the 1980s and 1990s, in particular, which episodes were contagious to other economies and why some crises were contagious and some were not. They find that financial crises tend to spread to other economies who shared a leveraged common creditor, including commercial banks, hedge funds and mutual funds. This is consistent with Frankel and Schmukler (1998) and Kaminsky, Lyons, and Schmukler (2004) who find that mutual funds were common actors in propagating the financial crises triggered by the currency devaluation in Mexico in 1994, which subsequently spread to Argentina and Brazil. Meanwhile, Kaminsky and Reinhart (2000) and Van Rijckeghem and Weder (2001) find that commercial banks were common creditors to the affected countries during the Asian Financial Crisis (AFC), as well as the subsequent Mexican and Russian crises for the latter study. Thus, regional financial contagion can arise when the source of the financial disturbance comes from a major financial centre, such as the GFC, or from an economy within the region, such as the AFC for the Asian economies.

#### 2.5.4 Recent Investigations of Financial Spillovers using FSIs

Prior to the development of FSIs, empirical studies in the EWI literature relied on identifying crisis episodes measured in binary nature - crisis or no crisis - which was identified using an event driven methodology. For example, Laeven and Valencia (2012) date the onset of banking crisis to be when there is “*significant signs of financial distress in the banking system*” and “*significant banking policy intervention measures in response to significant losses in the banking system.*” As mentioned earlier, a consequence of this event driven method of identifying financial episodes is that it misses periods marked by higher stress in financial markets but without systemic failures of financial institutions, currency runs or sovereign debt defaults. While not fitting the traditional definition of crises, such episodes are nonetheless significant if they had large adverse macroeconomic effects (Borio & Lowe, 2002). For instance, the US technology bubble burst in 2000-2001 had adverse macroeconomic effects domestically and thus to the US economy’s trade/financial partners, but it is not considered a financial crisis in most financial crisis databases<sup>10</sup>.

Another justification for focusing only on significant crisis episodes is that the determinants may differ compared to the “normal” phase of the financial cycle. This strategy is intuitive, as it seems reasonable to assume that the behaviour of economic agents differs during crisis periods. However, it raises the question of whether escalations of financial instability are attributable to significant movements in its determinants that are also able to explain financial stability conditions at normal levels. In addition, dating and identifying financial crises in the traditional manner limits country-level analysis of

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<sup>10</sup> See Laeven and Valencia (2012) and Reinhart and Rogoff (2009) for recent examples of databases of banking, debt and currency crisis.

financial spillovers in countries where crises have been rare, but still experience adverse financial episodes over time (Misina & Tkacz, 2009).

To address these issues, recent studies have relied on FSIs to detect early warning indicators and uncover the drivers of financial stress. Studies by Balakrishnan *et al.* (2011), Misina and Tkacz (2009), Duca and Peltonen (2011) and Park and Mercado Jr (2014) are representative of these efforts. Balakrishnan *et al.* (2011) construct FSIs for 26 emerging economies to investigate the transmission of financial stress from advanced to emerging economies. Using aggregated measures of financial stress in the advanced and emerging economies, they estimate a panel model of emerging market FSIs. Their panel model includes an advanced economy FSI, a set of common global determinants, financial stress in other emerging economies, trade and financial openness, and three variables that capture country-specific vulnerabilities to financial crisis, namely, the current account balance, fiscal balance and the level of foreign reserves. The authors find that common global financial and economic conditions play an important role in driving financial stress in emerging economies. Park and Mercado Jr (2014) extend Balakrishnan *et al.*'s (2011) panel analysis, by adding variables to capture regional and non-regional sources of financial stress in emerging economies. In addition to concurring with findings from Balakrishnan *et al.* (2011), the authors find the significance of financial stress from regional and non-regional emerging markets in influencing financial stress in emerging markets.

Balakrishnan *et al.* (2011) and Park and Mercado Jr (2014) find clear evidence of financial spillovers from advanced to emerging economies, while controlling for some domestic structural vulnerabilities. Nonetheless, these studies do not consider the role of economic and financial market imbalances that the early warning literature finds to be important precursors of financial crisis. Misina and Tkacz (2009) estimate linear and non-linear

threshold models to investigate if fast growth in asset prices and credit precede incidences of financial stress in Canada. An innovation of their study compared to Borio and Lowe (2002) is their use of an FSI, instead of a binary dependent variable<sup>11</sup>. Misina and Tkacz (2009) estimate their models using different permutations of credit and asset price measures. Their findings are consistent with Borio and Lowe (2002). Business credit appears as a reliable predictor of future financial stress in both linear and non-linear models<sup>12</sup>. Meanwhile, Duca and Peltonen (2011) use FSIs to evaluate the importance of external and domestic conditions in twenty-eight advanced and emerging economies. The authors identify periods when the FSI exceed the 90<sup>th</sup> percentile as “systemic events” and construct a binary variable to identify when such “systemic events” occurred. Using this as their dependent variable, the authors estimate discrete choice (logit) models with the domestic variables, foreign variables and both. A key result of their study is that the specification with the highest out-of-sample predictive power of high financial stress events includes both country-specific and common external variables.

The studies by Balakrishnan *et al.* (2011), Misina and Tkacz (2009), Duca and Peltonen (2011) and Park and Mercado Jr (2014) have provided greater insight to what the drivers of financial stress are. Nonetheless, an area of concern is that many of the explanatory variables are likely to be endogenous with financial stress, with causality running in both directions. Balakrishnan *et al.* (2011) and Park and Mercado Jr (2014) attempt to reduce these concerns by lagging their variables by one year. In Chapter 4, the FSIs that are constructed in Chapter 3 are used to investigate the sources of financial stress in the

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<sup>11</sup> In their assessment, Borio and Lowe (2002) measure credit conditions with total credit as a ratio of GDP. Misina and Tkacz (2009) consider a wider range of credit measures – growth of household credit, business credit and the ratio of total credit to GDP. There are more similarities in the definition of asset prices, except the latter study also include gold prices in Canadian dollars.

<sup>12</sup> See Cardarelli *et al.* (2011) and Claessens, Kose, and Terrones (2010) for stylized features of the behaviour of credit, asset prices and financial crisis historically across a wide range of countries.

ASEAN-5 economies using a panel data methodology. This chapter pays particular attention to the potentially endogenous relationship between financial stress and its determinants. It explores in depth the extent of two-way causality and uses an instrumental variable methodology to control for endogeneity in the panel model of financial stress.

## **2.6 Financial Stress, Real Economic Activity and Monetary Policy**

### **2.6.1 How Financial Stress Affects Real Economic Activity**

When financial instability escalates, among the most immediate concerns by the private sector and policy institutions alike are: How will economic activity be affected? As alluded to earlier, existing studies have yet to incorporate explicit measures of financial stability into mainstream macro models. Instead, two main methodological approaches are commonly taken in this context.

The first approach centres on analysing stylised features of financial crises. This methodology entails identifying periods when financial crisis occurred<sup>13</sup> and observing the behaviour of macroeconomic and financial aggregates before, during, and after the episode. Hong, Lee, and Tang (2010), Reinhart and Rogoff (2008b), Reinhart and Rogoff (2008a) and Claessens *et al.* (2010) are selected recent studies in this vein. Claessens *et al.* (2010) compare macroeconomic conditions in 21 OECD countries during recessions associated with credit contractions, housing market busts and financial crises with other recessions<sup>14</sup>. Output losses during recessions that are associated with financial crises, credit contractions or housing busts are larger and take a longer time to recover when compared with other recessions. For instance, the average duration of recessions from

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<sup>13</sup> This is usually done through referencing of existing studies or if they exceed thresholds in the magnitude of decline in asset prices such as equity or property.

<sup>14</sup> They define credit contractions and housing busts as declines that fall into the top quartile of their sample, and financial crises as episodes associated with substantial disruptions in the normal functioning of financial markets.

financial crises is approximately 2 quarters longer than recessions not associated with a financial episode. Hong *et al.* (2010) analyses the experiences of 21 Asian countries and find that recessions are more likely to occur and tend to be more severe in the face of large credit contractions and equity market declines.

The second approach involves cross-section econometric estimations. Rather than measure financial conditions directly, these studies seek to account for the response of economic activity to indicators of macroeconomic and financial market vulnerabilities. Berkmen, Gelos, Rennhack, and Walsh (2009), Blanchard, Das, and Faruquee (2010) and Kondor and Staehr (2011) are selected representative studies in this tradition. Blanchard *et al.* (2010) use this approach to estimate the impact of the GFC in 29 emerging markets. In their empirical model, they separate trade and financial channels. For trade, the authors use the share of exports to capture trade exposure and trade-weighted GDP growth. To isolate the impact of the crisis, they implicitly assume the crisis to be an “unexpected event.” This is done by adjusting the GDP variables on the left and right hand of their models by actual growth net of pre-crisis forecasts, as this transformation nets out the economic fundamentals that determined the pre-crisis path of GDP growth. Kondor and Staehr (2011) closely follow this methodology to analyse the experiences of the European Union countries during the GFC. Their estimations include more variables to capture a richer set of vulnerabilities such as fiscal health in addition to the trade and financial channels. In all of these papers, the time-frame of the estimations are isolated to the crisis period as an attempt to capture only the impact of the crisis<sup>15</sup>.

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<sup>15</sup> The crisis period is taken to be 2009 in Berkmen *et al.* (2009), 2008-Q4 to 2009-Q1 in Blanchard *et al.* (2010) and 2008-Q3 to 2009-Q3 in Kondor and Staehr (2011).

### 2.6.1.1 The Transmission Channels

Despite the lack of an explicit measure of financial stability to infer the growth effects from adverse financial stability episodes, existing macroeconomic models nonetheless do shed some light on the transmission channels.

#### (a) *Access to Bank Credit*

A main channel in which financial stress affects real economic activity is through access to financing. Higher financial stress can lead to lower access to financing by firms and households as the economic outlook deteriorates and asset prices decline. This occurs through several mechanisms. From borrowers' perspective, the financial accelerator mechanism posits that the external finance premium<sup>16</sup> increases when an adverse financial shock leads to a decline in net worth as asset prices fall and the economic outlook deteriorates (Bernanke & Gertler, 1989; Garber & Grilli, 1989). This happens because lenders perceive investments as riskier and have lower expected profits. The higher cost of funds then reduces access to desired financing and causes a decline in spending that is more persistent compared to the size of the initial shock. Meanwhile, the bank capital and bank lending channels emphasise the role of lenders. Adverse financial shocks erode banks' capital base through lower profits, losses on existing loans and other assets on their balance sheets. This forces them to reduce lending (Bernanke & Blinder, 1992; Kashyap & Stein, 1995; Van Den Heuvel, 2002). This leads firms to reduce capital expenditures and households to reduce spending<sup>17</sup>.

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<sup>16</sup> Defined as the difference in cost of financing an investment between internally and externally sourced funds.

<sup>17</sup> See Dell'Ariccia, Detragiache, and Rajan (2008) and Mendoza and Terrones (2008) for other selected examples of empirical studies that address the relationship between credit and real economy.

### (b) *Access to Equity Finance*

In equity markets, the Tobin's  $q$  mechanism depicts how financial stress affects the cost of equity and suppresses economic activity (Tobin, 1969). This mechanism establishes a positive link between equity prices and capital investments by relating the market value of firms to the replacement cost of capital goods. Since equity prices decline during high stress episodes, the market value of firms relative to their cost of capital goods also declines. Firms therefore need to issue more equity relative to periods when their market value is higher. This depresses fund raising in equity markets and leads to a decline in investment expenditure.

### (c) *Uncertainty*

Financial stress is also transmitted to the economy through higher uncertainty in financial markets and the economic outlook. Bloom (2009) studies the transmission of uncertainty through a reduced-form VAR model and a structural firm-level model of investment. Firms hire and invest when business conditions are above a certain level and fire and disinvest when business conditions are below a threshold. There is a range of business conditions where firms find it optimal to take no action. This region of inaction increases with the level of uncertainty. He finds a sharp fall, a rebound and an overshoot in employment, output and productivity<sup>18</sup>, and explains that hiring and investment initially fall rapidly as firms hold back on planned projects and adopt a wait-and-see approach. Lower employment and investment by higher productivity firms then cause a fall in productivity. As the uncertainty dissipates, firms react to pent-up demand for capital and labour, causing an overshoot in investment, employment and productivity. Consumer spending is also affected by uncertainty, as consumers delay spending amid uncertain

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<sup>18</sup> For instance, industrial production falls rapidly for 4 months, rebounds after 7 months and subsequently overshoots before its effects gradually dissipates approximately 3 years after the uncertainty shock.



employment and wealth statuses. Lee, Rabanal, and Sandri (2010) estimate a three variable VAR and find that higher uncertainty leads to a hump-shaped decline in household wealth and consumption over approximately 2 years. Carrière-Swallow and Céspedes (2013) analyse the impact of uncertainty shocks on investment and private consumption in developed and emerging markets using a VAR model. The authors find notable differences between developed and emerging economies. In developed economies, they find that investment displays a similar dynamic as Bloom (2009). However, the response of investment in emerging economies is larger and there is no subsequent overshoot. For private consumption, the authors find that the impact in emerging economies is larger compared to developed economies.

#### **2.6.2 The Role of Monetary Policy and How Monetary Policy Transmission Changes during Episodes of Financial Instability**

Monetary policy is one of the major policy instruments that can influence real economic activity and prices in the short-run. Thus, when financial stress episodes escalate and growth starts to moderate, attention is often turned to the role of monetary policy to restore macroeconomic stability. What is the role of monetary policy when financial stress increases and the real economy slows? There is no conceptual agreement yet on whether a monetary policy regime that best promotes price and output stability should respond to financial stability. The question of whether financial factors should enter the monetary policy reaction function is still being debated<sup>19</sup>.

One literature analyses the desirability for monetary policy to respond to asset prices and credit through NKMs. In a NKM with equity market cycles, Bernanke and Gertler (1999, 2001) find that a monetary policy rule based on inflation targeting is optimal for

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<sup>19</sup> See Baxa, Horváth, and Vašíček (2013) for a more extensive review of this literature.

stabilising inflation and output. This arises because stock market booms lead to stronger demand and higher inflation. It is therefore sufficient to consider the inflation forecast alone to set monetary policy once the informational content of asset prices in predicting inflation is incorporated<sup>20</sup>. Cecchetti, Genberg, Lipsky and Wadhvani (2000) (CGLW) find, in contrast, that it is optimal for central banks to include equity prices in their policy reaction function. A key departure in the underlying assumptions from Bernanke and Gertler (1999, 2001) is that the central bank has information on whether the equity prices are driven by fundamentals and the timing of the bubble burst. More recently, Christiano *et al.* (2010) find that there are welfare gains from expanding the Taylor rule within a NKM to include credit. Cúrdia and Woodford (2010) analyse the benefits of adding credit and credit spreads to the Taylor rule within a NKM. They show that there are economic benefits to augmenting the Taylor Rule with credit spreads and, to a smaller extent, credit as well.

One of the highlighted pitfalls of a monetary policy approach that responds only to inflation is that past experiences reveal that asset price booms are not always inflationary. This is pointed out, among many others, by Borio and Lowe (2002), Bordo and Wheelock (2004) and Christiano *et al.* (2010). For example, Borio and Lowe (2002) find three stylised features of financial imbalances - rapid asset price increases, fast credit expansions and above average capital accumulation. The authors also provide evidence from many financial crises that inflation does not systematically increase during the build-up to financial crises or unwinding of lending booms, but are deflationary thereafter. This feature induces an asymmetry among the financial cycle, inflation and monetary policy. Specifically, monetary policy stays unchanged during the build-up of financial

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<sup>20</sup> Despite their strong stance against systematic reactions to asset prices, Bernanke and Gertler (2001) caveat that this does not preclude short-term monetary policy interventions during periods of financial instability.

imbalances because there is no inflation, but is loosened aggressively after the onset of the crisis due to deflationary pressures. The major pitfall is that because the monetary policy stance was not tightened earlier in the financial cycle, there is subsequently less space in how much monetary easing the central bank can do, at least in its conventional instrument. Borio and Lowe (2002, 2004) thus advocate explicit consideration of financial imbalances when setting monetary policy.

Despite the lack of intellectual consensus, there is evidence that many central banks do respond to financial factors in practice. A survey of over ninety central banks in both advanced and emerging economies reveal a significant positive correlation between monetary policy and financial stability concerns, including financial sector solvency, credit rationing and asset price volatility (Roger & Sterne, 2000). Studies have also estimated the monetary policy reaction functions of central banks to search for indications of explicit attention to financial factors. Borio and Lowe (2004) estimate several permutations of the monetary policy reaction functions for the United States, Germany, Australia and Japan. They start with a standard Taylor rule specification and gradually add three measures of financial imbalances - the credit gap, equity price gap and a dummy variable capturing banking sector stress. Their results reflect variations in the reaction functions across countries. The German central bank paid little attention to financial imbalances in its monetary policy decisions. In Australia, the equity and credit gaps are jointly significant predictors of monetary policy movements. In Japan, there is evidence that monetary policy responds asymmetrically to credit and equity gaps, more when the gaps are negative. In the United States, the study also finds evidence that the Federal Reserve responds asymmetrically to financial imbalances. Policy interest rates are more responsive to negative credit and equity gaps than positive gaps.

More recently, Baxa *et al.* (2013) test the significance of financial stress in interest rate decisions using a time-varying specification of monetary policy in five advanced economies (United States, United Kingdom, Australia, Canada and Sweden). The authors find that central banks tend to be unresponsive to financial stress at low and normal levels, but often ease their policy rates in response to higher financial stress, in particular, to equity and bank related financial stress.

### **2.6.3 Utilising FSIs to Measure Interactions in the Real Economy, Financial Instability and Monetary Policy**

Since the development of FSIs began after the GFC episode, studies have started to incorporate FSIs into VAR-based models predominantly to assess how financial stress influences monetary policy behaviour and effectiveness, and to assess the various linkages between financial stress and the real economy. Representative studies are Li and St-Amant (2010), Davig and Hakkio (2010), Hollo, Kremer and Duca (2012), Mallick and Sousa (2013), Roye (2011), Afonso, Baxa, and Slavík (2011), Park and Mercado Jr (2014) and Kremer (2015). Although the specific FSIs used in these studies differ, all reflect stress in financial markets through a combination of declining and volatile asset prices and higher bond yields/spreads.

Li and St-Amant (2010) estimate a threshold VAR for Canada with a FSI, GDP growth, inflation and the real overnight policy rate. Their goal is to analyse the role of financial stress as a source of non-linearity among the other macro-relationships. They find that when they characterise the economy as being in two possible states - low and high stress - monetary policy changes increase the likelihood of transitioning between these states. They also find that monetary policy is more effective in the high-stress regime.

Davig and Hakkio (2010) estimate a broadly similar regime switching model for the US economy, using a FSI and an index of economic activity. The authors find that in the low-

stress regime, the impact of higher financial stress in lowering economic activity is modest. However, the impact increases substantially when the regime switches into the high-stress (distressed) regime. Hollo *et al.* (2012) construct a FSI, called the Composite Indicator of Systemic Stress in their paper, for the euro area. They then estimate a threshold VAR model with the FSI and growth of industrial production, using the FSI as their threshold variable. In line with Davig and Hakkio (2010), they find that industrial production experiences a much larger decline to financial stress shocks in the high stress regime compared to the low stress regime.

Mallick and Sousa (2013) estimate a Bayesian Structural VAR and a VAR model with sign restrictions, and find that higher financial stress leads to lower output and a decline in the monetary policy interest rate. Roye (2011) estimate Bayesian VAR models for Germany and Euro Area using the FSI, GDP, inflation and a short-term interest rate as variables. He finds that higher financial stress leads to a decline in output and inflation.

Most existing studies in this literature have tended to focus on either the US economy or Euro Area economies. This is not surprising given that recent episodes of financial stress originated from those areas in the form of the GFC and the later euro debt crisis. More recent studies covering Asian and other emerging economies, such as Tng (2013) and Park and Mercado Jr (2014), estimate VAR models to analyse financial spillovers from advanced to emerging economies. Thus far, none of the analyses have focused on the interactions between financial stress, the real economy and monetary policy. Chapter 5 explores these inter-linkages further for the case of the ASEAN-5 economies from an estimated SVAR model with an open-economy structure. Specifically, this analysis focuses on the impact of financial stress on the real economy, how this transmission occurs and, finally, how financial stress alters monetary policy transmission.

## **2.7 Conclusion**

In the effort to maintain macroeconomic and financial stability, having the appropriate surveillance tools and a sound understanding of the linkages within financial markets and between financial markets and the real economy are of utmost importance. To restore financial and macroeconomic stability during times of elevated financial stress, knowledge of how policy effectiveness changes is critical.

This survey chronicles the modelling efforts that have taken place from a historical perspective. Knowledge of past efforts is pertinent to understand why macro models have evolved to their current state and so that past modelling mistakes are not made again. As illustrated in this survey, despite the voluminous efforts in these broad fields, there are areas that can benefit from further analysis. In particular, the incorporation of a measure of financial stress into macro models seems like a fruitful path going forward to better understand the effects of financial instability on macroeconomic stability and how major policy instruments' effectiveness change during such periods. This survey identifies three specific knowledge gaps that this thesis pursues.

The first area pertains to the measurement of financial stress. The second area of inquiry pertains to the sources of financial stress across the entire financial cycle, instead of just crisis periods. The final area of inquiry is in the linkages among financial stress, real economic activity and the transmission of monetary policy.

## CHAPTER 3 : THE MEASUREMENT OF FINANCIAL STRESS IN ASEAN-5 ECONOMIES<sup>21</sup>

### 3.1 Introduction

This chapter develops a methodology to measure financial stability conditions by constructing indices reflecting stress in specific asset market segments and at the systemic level for the ASEAN-5 economies of Indonesia, Malaysia, the Philippines, Singapore and Thailand. Called Financial Stress Indices (FSIs), the indices are a natural extension from the approach most commonly used in financial crisis studies, in which the crisis variable is binary in nature - “crisis” or “no crisis”. By presenting financial stress on a continuous scale in index form, the FSIs can be used to measure the relative severity of past crises and as a benchmark for emerging crises.

Individual indicators of financial stress are constructed from asset prices to build a set of market-specific FSIs to gauge stability conditions in the banking sector, equity market, foreign exchange market, domestic bond market. The market-specific FSIs are then weighted according to the markets’ relative importance as a source of finance to the economy. Low and high values reflect, respectively, buoyancy and distress in financial markets. Periods with values above a pre-defined threshold are defined as periods of financial stress. Compared to existing ASEAN-5 FSIs, most notably from Balakrishnan *et al.* (2011) and Park and Mercado Jr (2014), the FSIs constructed here incorporate an additional indicator of stress from the domestic bond market and a new weighting methodology that weights the stress indicators proportional to the financing size of the matching asset market.

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<sup>21</sup> The main findings from this chapter has been published as Tng et al. (2012).

To present the results, the FSIs are used to document and compare stylised facts of financial episodes in the region. This includes the frequency, duration and magnitude of stress episodes, and the contribution of individual market segments to overall financial stress during such episodes. The FSIs are subsequently used to examine how historical financial episodes unfold across markets and countries from a regional perspective. This is done by analysing the extent of clustering in the peaks of the FSIs and the proportion of countries under financial stress in each of the markets at any point in time. By matching periods when the peaks cluster and the onset of financial stress to well-known financial events, stress episodes are identified as regional and global episodes.

The remaining paper is organised as follows: Section 3.2 presents the methodology and describes how episodes of financial stress are identified. Section 3.3 presents the results, including stylised statistics of financial stress episodes and a discussion of the features of identified episodes from country-specific, regional and global perspectives. The final section concludes the paper.

## **3.2 Methodology**

### **3.2.1 Data**

FSIs are constructed for Indonesia, Malaysia, the Philippines, Singapore and Thailand (ASEAN-5). The sample period ranges from January 1997 to December 2013. This period covers notable regional and global episodes such as the Asian Financial Crisis (AFC) in 1997, the U.S. technology bubble burst (tech bust) in 2000 and the Global Financial Crisis (GFC) in 2007.

The FSIs are in monthly frequency. S&P Emerging Market Indices (S&P/IFCG) are used as the benchmark stock market indices, except for Singapore where the Straits Times Index is used. These series are extracted from the World Bank's Global Economic Monitor (GEM) database. Banking sector stock indices are sourced from Haver and



Bloomberg. In cases where banking sector indices are not available, the finance sector indices are used. Treasury yields are collected from International Financial Statistics (IFS) and the individual central bank websites. Foreign reserves (excluding gold) and bilateral exchange rates are also from the IFS. Singapore's Nominal Effective Exchange Rate (NEER) is from the Bank for International Settlements (BIS). The variables used to compute the weights to construct the overall FSIs are from the BIS, IFS and World Federation of Exchanges. Appendix A contains a detailed description of the data used and their sources.

### **3.2.2 Constructing the Financial Stress Index**

An overall FSI and 4 market specific FSIs are constructed for each ASEAN-5 economy to measure overall financial stress and stress in the banking sector, equity market, foreign exchange market and domestic bond market. The methodology for the overall FSI is broadly similar to Balakrishnan *et al.* (2011), with 2 key departures: First, an interest rate volatility indicator is used to reflect stress in the domestic bond market. This market has not been accounted for in existing emerging market FSIs. Secondly, the market-specific FSIs are weighted based on the relative sizes of their corresponding financing markets, instead of the equal weights approach by Balakrishnan *et al.* (2011) and Yiu *et al.* (2010) or the principal component analysis based weights as in Hakkio and Keeton (2009) and Park and Mercado Jr (2014). In doing so, the impact of financial stress from specific markets at the systemic level is tied to the level of stress emanating from the market itself and to the financial structure of the economy, specifically, the liability side of the economy's balance sheet. Financial stress that originates from larger financing markets will therefore have a proportionately larger impact on overall financial stress.

Financial stress is defined as a period when the financial system's intermediating functions are impaired which causes a decline in the supply of financing. Financial stress is associated with 3 attributes. First, is an increase in expected losses on risky assets. This

is reflected by declines in the prices of risky assets and occurs during periods of stress as market valuations on financial assets are lowered in accordance with lower expected cash flows and higher risk aversion. The second feature of stress is increased uncertainty in financial markets. Hakkio and Keeton (2009) differentiates the types of uncertainty into uncertainty over the fundamental value of assets, uncertainty over the behaviour of other investors and asymmetric information. This facet of stress manifests as volatility spikes in asset prices. The final feature of stress is increased demand for safe and liquid assets. This occurs as risk appetite falls and causes investors to reduce their holdings of risky assets in exchange for safe and liquid assets. This final feature of stress is reflected by volatile increases in sovereign bond prices and volatile declines in the prices of risky assets.

The indicators used to construct the FSIs are derived from asset prices and bond yields. This means that the indices rely on the informational content of asset prices to reflect stress and are thus agnostic about their sources. The following 4 sub-sections describe the variables in detail.

### 3.2.2.1 Construction of the Financial Stress Indicators

#### (a) *Banking Sector*

The banking sector index comprises of two variables that measure returns and volatility in the sector. They are defined as:

$$\beta = \text{cov}(b, m) / \text{var}(m) \quad (\text{Equation 3.1})$$

$$\text{Rel\_Ret} = (100 + m) / (100 + b) \quad (\text{Equation 3.2})$$

$b$  and  $m$  are year-on-year percentage returns in the bank equity index and overall benchmark equity index.  $\beta$  reflects the level of volatility in the returns of bank stocks relative to the overall equity market. The covariance and variance are calculated over a

rolling one-year period. *Rel\_Ret* measures returns in bank stocks relative to overall stock market returns. Higher values in both variables reflect higher uncertainty and lower returns in bank related equities relative to the overall market, thus indicating increased stress in the banking sector.

(b) ***Equity Market***

The equity market index contains two variables that measure returns and volatility. They are year-on-year returns and the conditional variance from a GARCH<sup>22</sup> (1,1) model of monthly stock market returns<sup>23</sup>. The returns are multiplied by -1, so that lower returns indicate higher stress.

(c) ***Foreign Exchange Market***

Foreign exchange stress is measured by an index of Exchange Market Pressure (EMP). This index follows from Kaminsky and Reinhart (1999) and Balakrishnan et al. (2011), and is defined as:

$$EMP = \frac{e - \mu_e}{\sigma_e} - \frac{r - \mu_r}{\sigma_r} \quad (\text{Equation 3.3})$$

$e$  and  $r$  are month-on-month changes in the nominal exchange rate and foreign reserves excluding gold.  $\mu_e$  and  $\mu_r$  are the means of  $e$  and  $r$ .  $\sigma_e$  and  $\sigma_r$  are standard deviations of  $e$  and  $r$ . The US dollar is used as the reference currency, as suggested by Levy-Yeyati and Sturzenegger (2005). Foreign exchange stress is thus reflected by faster exchange rate depreciations and depletion of foreign reserves.

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<sup>22</sup> Generalized Autoregressive Conditional Heteroskedasticity

<sup>23</sup> The conditional mean equations are estimated as ARMA processes with lags selected based on the Schwarz criteria.

(d) ***Domestic Bond Market***

As previously mentioned, a characteristic of financial stress is increase demand for safe and liquid assets as investors adjust their portfolios away from risky assets. Government bonds usually assume the role of safe and liquid assets. This implies that volatile declines in their yields should occur during stress episodes. However, two issues arise within the context of this sample. First, government bond yields, particularly short-term treasuries, which is the only bond market data available for all countries during the period under study, are heavily influenced by monetary policy. This means that in addition to a higher demand for government bonds, volatile decreases in yields also reflect the deliberate easing of monetary policy. Secondly, treasury yields may increase if interest rates are raised to support the depreciating exchange rates, as was done by several ASEAN-5 economies during the AFC. Furthermore, treasuries in countries in the midst of balance-of-payments or debt crises carry substantial credit and foreign exchange risks that cause yields to increase, not decrease as if they were regarded as safe assets.

Addressing these issues require distinguishing between movements in yields due to monetary policy influences and movements due to shifts in market sentiments. Following from Hatzius, Hooper, Mishkin, Schoenholtz, and Watson (2010), this study uses overnight interbank interest rates as proxies of monetary policy and regresses treasury yields on interbank interest rates. The residuals from the regression are then used to construct the stress indicator, which is defined as the 12-month rolling standard deviation of the residuals. Doing so purges the informational content of monetary policy from treasury yields, as the residuals represent only the yield dynamics that are uncorrelated

with monetary policy<sup>24</sup>. A variable measuring returns is excluded from the bond market FSI because of the directional ambiguity of sovereign yields under financial stress.

### **3.2.2.2 Forming the Financial Stress Indices**

All indicators are standardised prior to aggregation by subtracting them with their means and dividing them with their standard deviations. The market specific FSIs are simple averages of the standardised variables pertaining to their respective markets. The overall FSIs are weighted averages of the market specific FSIs. The weights are constructed to reflect each market's share in the aggregate financial structure of the economy. Banking sector financing, or bank credit, is measured using domestic bank loans, equity finance is reflected by market capitalisation, foreign currency finance is calculated as the sum of international bonds and external loans. Finally, the size of the domestic bond market is measured by the sum of local currency denominated private and sovereign bonds. The weights are updated on a quarterly basis to account for changes in the financing profiles of the economies. A summary of the weights is displayed in Table 3.1.

The shares are presented as averages over the period specified for each country. The figures reflect two key trends in the ASEAN-5's financial structure. Firstly, there is a shift away from a reliance on foreign sources of financing. This is observed especially in external loans but also for international bonds to a smaller extent as well, as the decline in financing shares in the former tended to be much larger compared to the later. Secondly, there is a shift in the source of financing away from the banking sector towards domestic capital markets, as reflected by the decline in shares from banking sector loans and increasing shares in either the equity market, domestic bond market or both. Overall,

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<sup>24</sup> This is done for all the countries with the exception of Singapore as its monetary policy is conducted via the exchange rate. In its case, the variable is computed as the rolling 12-month standard deviation in the treasury yield.

the banking sector and equity market have historically and remain the two largest sources of finance in all sample countries. This weighting method, originally proposed by Illing and Liu (2006), possesses several advantages. The resulting overall FSIs are driven by changes in the financial structure as well as movements in market specific stress. Furthermore, allowing for variability in the weights across countries and time means that the overall FSIs are adaptive to the diversity in the financial structure across countries as well as its changes over time.

**Table 3.1: Financial Structure in ASEAN-5 Economies**

		Average Share of Total Financing (%)		
		1997-2004	2005-2013	1997-2013
<b>Banking Sector</b>	Indonesia	37.0	31.3	34.0
	Malaysia	33.7	29.7	31.6
	The Philippines	32.8	25.8	29.1
	Singapore	23.3	20.4	21.7
	Thailand	58.2	40.8	49.0
<b>Equity Market</b>	Indonesia	19.1	38.1	29.1
	Malaysia	36.2	35.9	36.0
	The Philippines	23.2	34.9	29.4
	Singapore	25.3	38.0	32.0
	Thailand	17.8	28.4	23.4
<b>Domestic Bonds</b>	Indonesia	17.8	17.8	17.8
	Malaysia	20.3	26.1	23.4
	The Philippines	18.7	20.1	19.4
	Singapore	4.9	6.4	5.7
	Thailand	8.0	25.6	17.3
<b>External Loans</b>	Indonesia	20.1	7.9	13.6
	Malaysia	5.2	3.9	4.5
	The Philippines	10.2	6.2	8.1
	Singapore	43.6	31.0	36.9
	Thailand	11.5	3.7	7.4
<b>International Bonds</b>	Indonesia	6.0	5.0	5.4
	Malaysia	4.7	4.4	4.5
	The Philippines	15.1	13.0	14.0
	Singapore	3.0	4.3	3.7
	Thailand	4.4	1.6	2.9

Sources: Author's calculations

### 3.2.3 Identifying Incidences of Financial Stress

Having built the FSIs to monitor financial stress on a continuous scale, a practical consideration is how they can be used to identify what levels of stress are high enough to warrant closer attention. Two options are available: The first option is to use past crises as reference points. Here, values of the FSIs that are above the level observed on a chosen date are classified as “stressful”. The second option is to apply a statistical criterion to set a threshold. This is done by either choosing values above a set number of standard deviations above the mean or values that fall within a chosen percentile range.

In both cases, a trade-off exists when setting the threshold. A high threshold increases the risk of missing out on less severe but nonetheless financially stressful periods. For example, setting the threshold for ASEAN countries at levels observed during the AFC period poses such a risk since most of them suffered their most severe banking and currency crises in recent history during that period. Meanwhile, setting the threshold too low will result in many false alarms.

This analysis uses an 80<sup>th</sup> percentile threshold to identify incidences of financial stress. In comparison, Hakkio and Keeton (2009) use a 90<sup>th</sup> percentile cut-off for their US FSI. A less sensitive 80<sup>th</sup> percentile cutoff is chosen in this analysis because financial market volatility tends to be higher in emerging economies. This is noted in Patel and Sarkar (1998) when measuring and analysing equity market crises. In similar vein, Cardarelli *et al.* (2011) use a 1 standard deviation above the underlying trend as a threshold for their sample of developed economies, while Balakrishnan *et al.* (2011) use a less sensitive threshold of 1.5 standard deviations above the average for their sample of emerging economies.

The percentile method of computing the threshold is preferred to the others as it is less sensitive to extreme values compared to the standard deviation method, and does not

require subjectively selecting a reference event for each country as “stressful”. To avoid double counting similar stress episodes, those occurring within a 3-month window are considered as the same episode<sup>25</sup>.

### 3.3 Results

#### 3.3.1 Stylised Characteristics of Financial Stress in the ASEAN-5

Figure 3.1 to Figure 3.5 illustrate the FSIs for the ASEAN-5 economies from January 1997 to December 2013, beginning with the overall FSIs and followed by the market FSIs for the banking sector, equity market, foreign exchange market and domestic bond market. Table 3.2 reports the frequency and duration of stress episodes across countries.

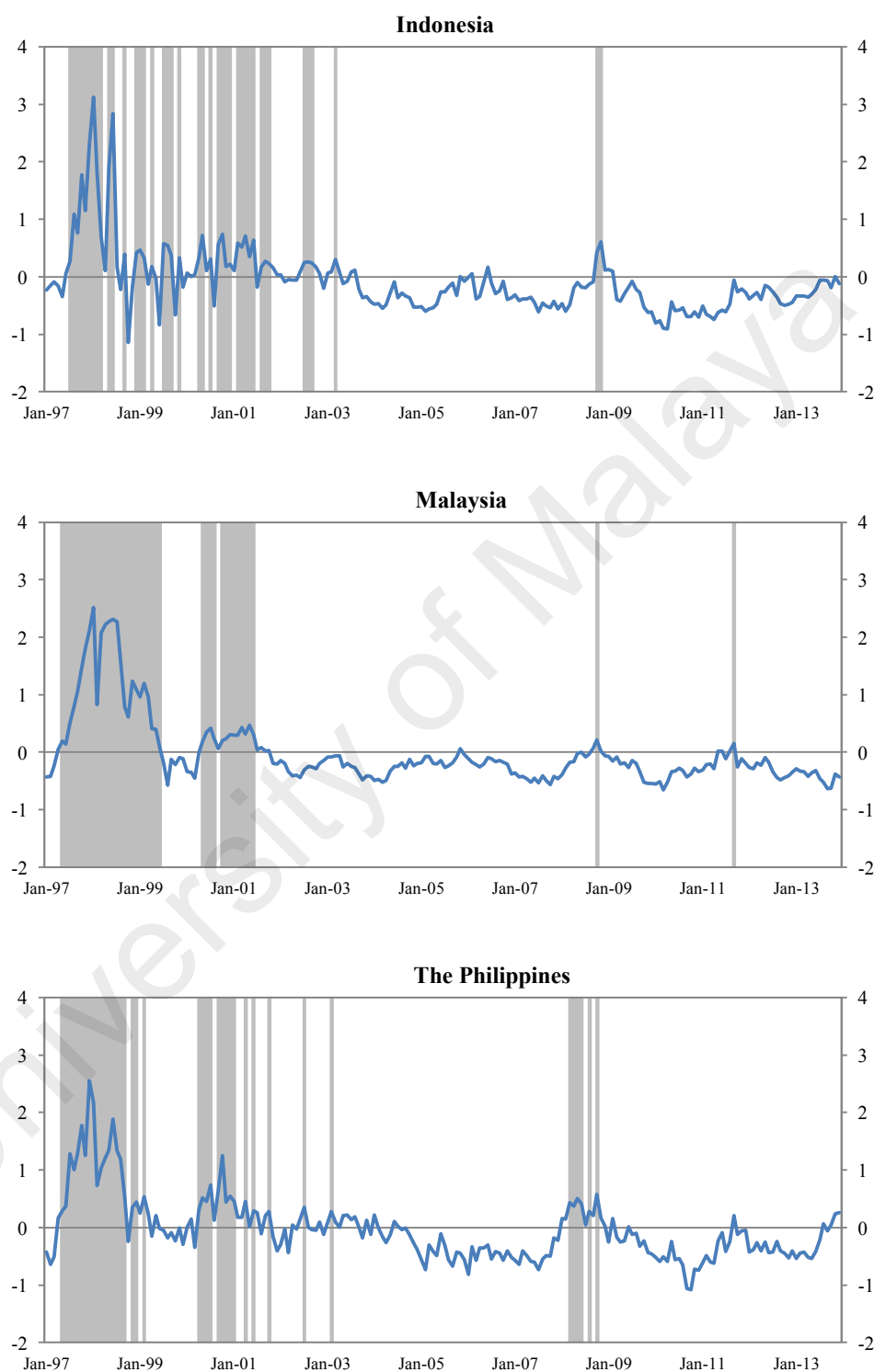
Broadly, the figures and table show that periods of higher financial stress centre around 3 periods, corresponding to the Asian Financial Crisis (AFC) in 1997, the technology bubble burst (tech bust) in 2000-2001 and the Global Financial Crisis (GFC) in 2007-2009. As expected, the FSIs rose to their highest levels and remained at “high stress” levels (above the 80<sup>th</sup> percentile threshold) the longest during the AFC period (Figure 3.1 and Table 3.2). Trends among the country level overall FSIs broadly coincide with each other. A visual inspection of the overall FSIs reflects a similarity in the relative severity of the aforementioned episodes, in terms of magnitude and duration. The AFC is the most severe in magnitude and duration. Perhaps surprisingly, the tech bust ranks above the GFC in magnitude and duration in all countries except Singapore, which recorded a

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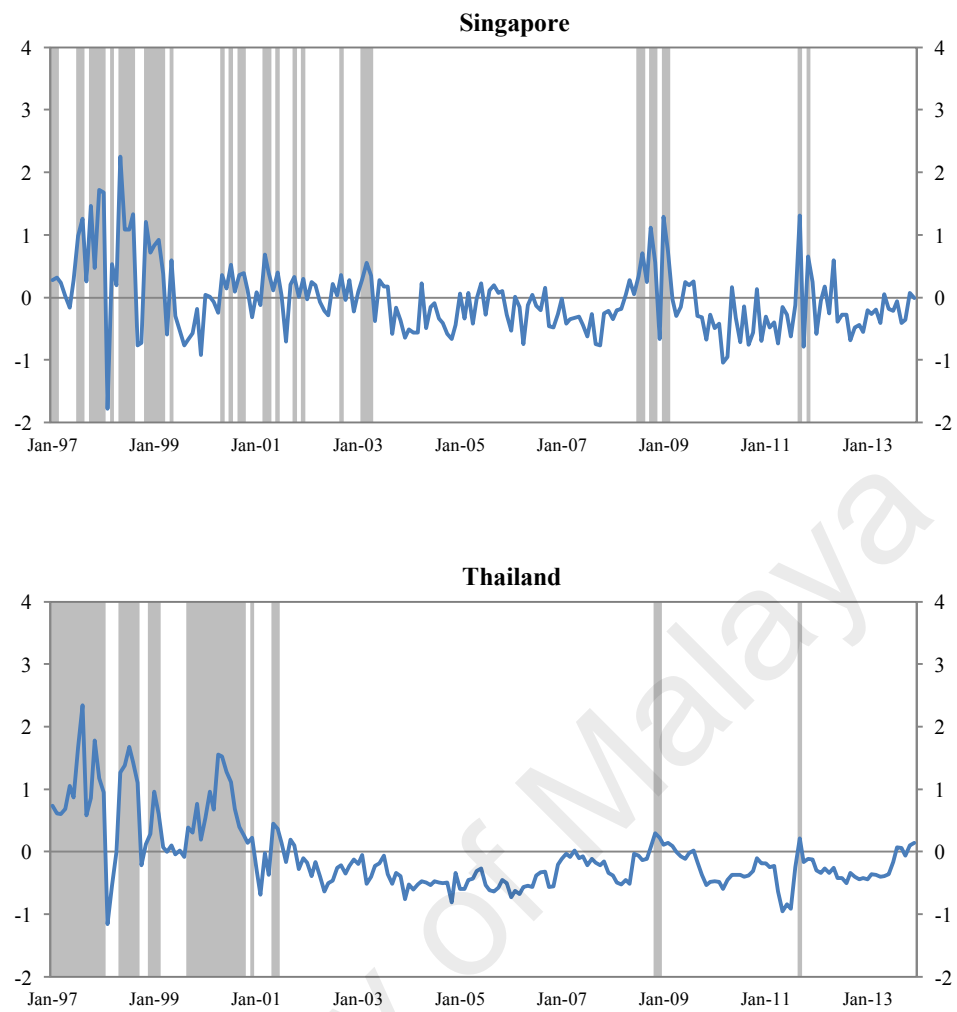
<sup>25</sup> Defining “stress” episodes premised on setting thresholds in the indices is lends to a conceptual distinction in interpretation compared to how a “crisis” is identified in the financial crisis literature. The financial crisis literature relies, in large part, on public sector bailouts to identify banking crises. For instance, Laeven and Valencia (2012) identify a banking sector crisis to be when there is “...significant banking policy intervention measures in response to significant losses in the banking system.” This definition lends to an interpretation of solvency or liquidity related stress from the banks’ balance sheet point of view, and is a useful indicator for decisions on whether and when bailouts are needed. On the other hand, the FSIs rely on indicators constructed from asset prices to reflect stress. They therefore reflect the financial stress as perceived by market participants. It is intuitive for market participants to perceive reduced stress on the banking system, even as many banks are facing solvency or liquidity problems if markets expect banks to receive a bailout.



higher magnitude of financial stress but over a shorter duration during the GFC compared to the tech bust.



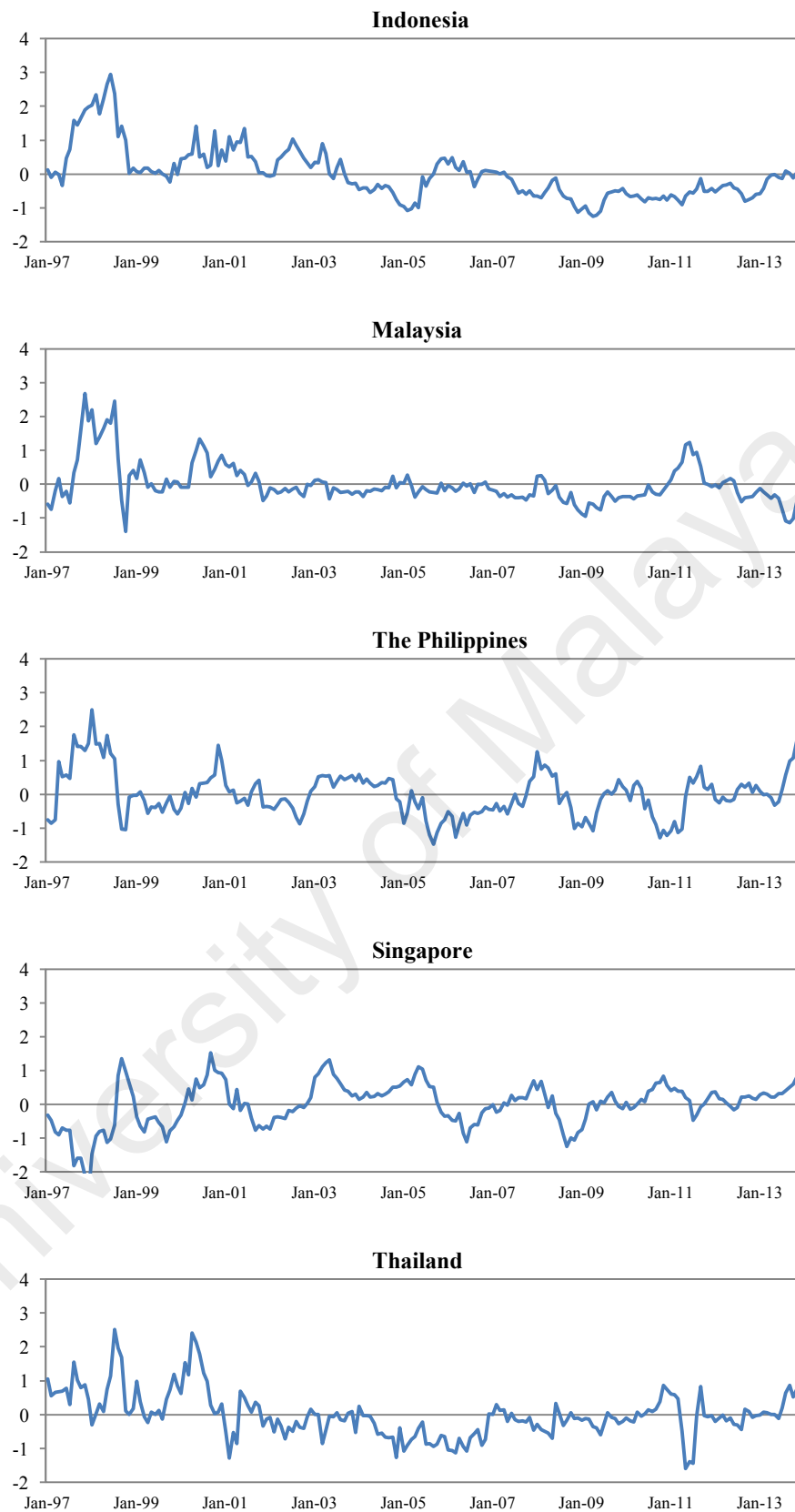
**Figure 3.1: Financial Stress in the ASEAN-5 Economies**



Source: Author's calculations

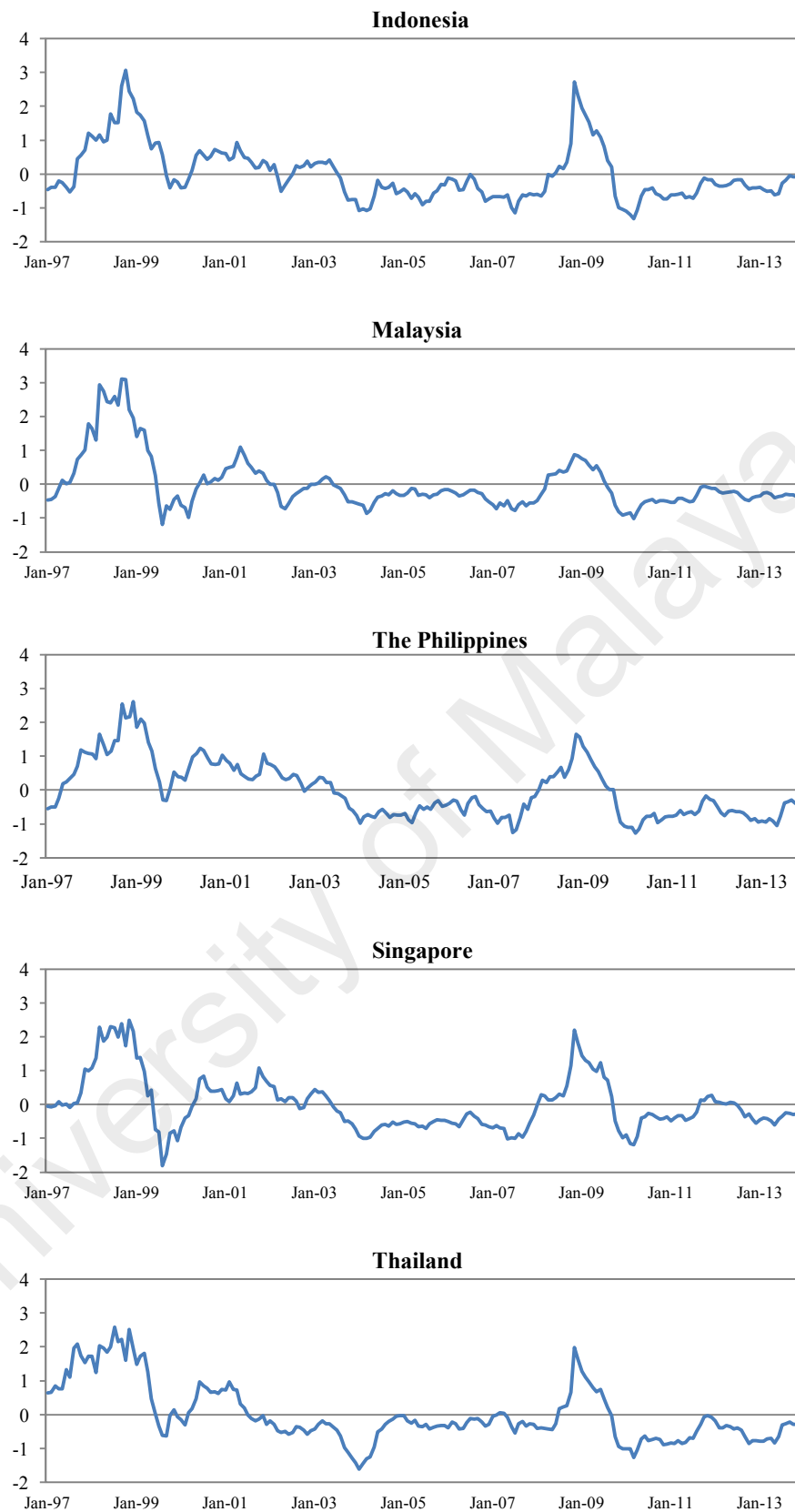
Note: Shared areas indicate periods under financial stress

**Figure 3.1: Continued**



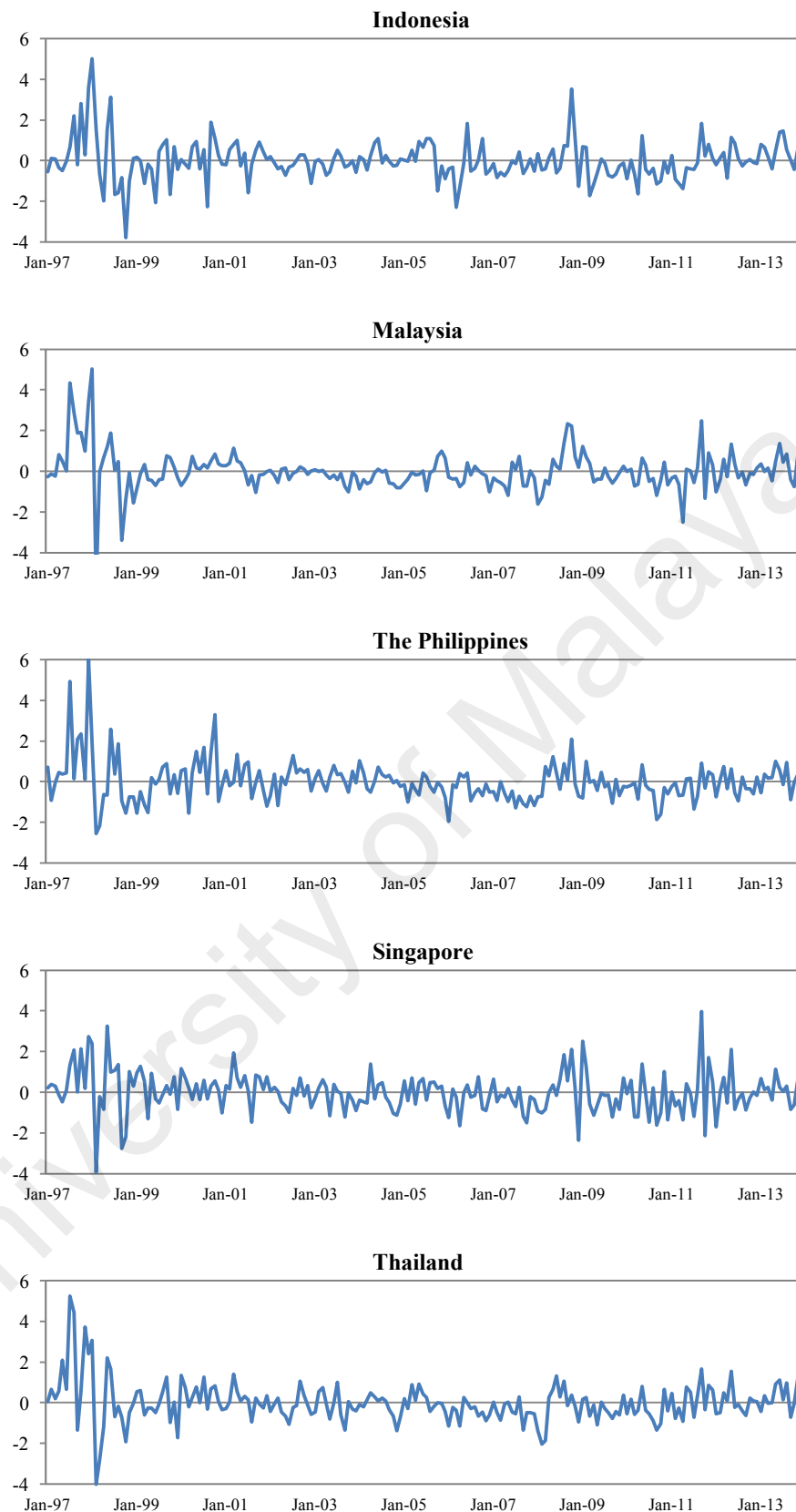
Source: Author's calculations

**Figure 3.2: Banking Sector Stress**



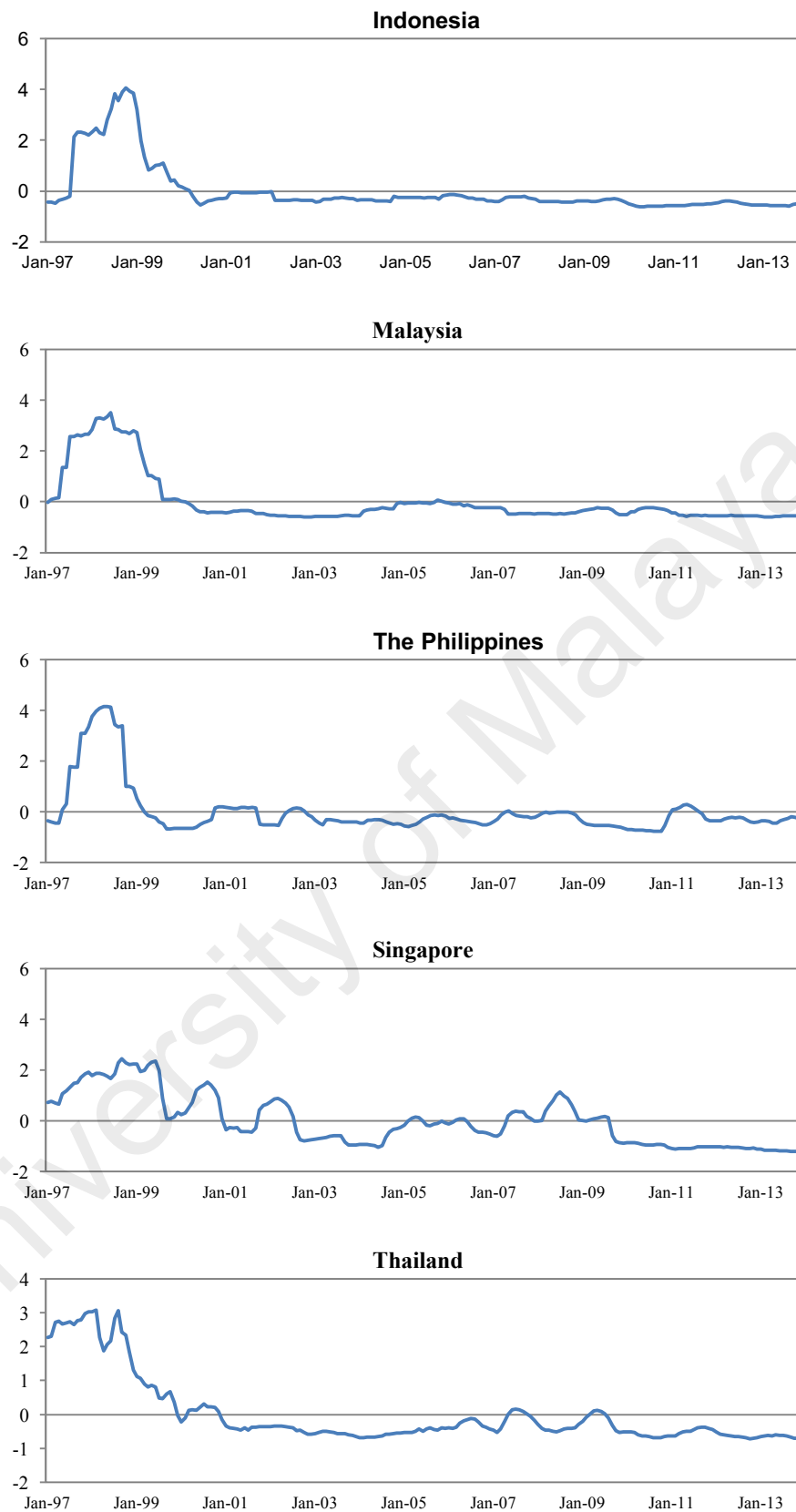
Source: Author's calculations

**Figure 3.3: Equity Market Stress**



Source: Author's calculations

**Figure 3.4: Foreign Exchange Market Stress**



Source: Author's calculations

**Figure 3.5: Bond Market Stress**

**Table 3.2: Duration and Frequency of Financial Stress**

	Indonesia	Malaysia	The Philippines	Singapore	Thailand	Average
No. of Episodes	5	4	7	11	6	6.6
Avg. Duration (Months)	8.2	10.3	6.0	3.7	6.8	7.0
<b>Months Under Stress During Selected Financial Episodes</b>						
AFC	20	26	20	15	21	20.4
Tech bust	15	13	12	11	17	13.6
GFC	2	1	6	7	2	3.6
Other Episodes	4	1	3	8	1	3.4

Source: Author's calculations

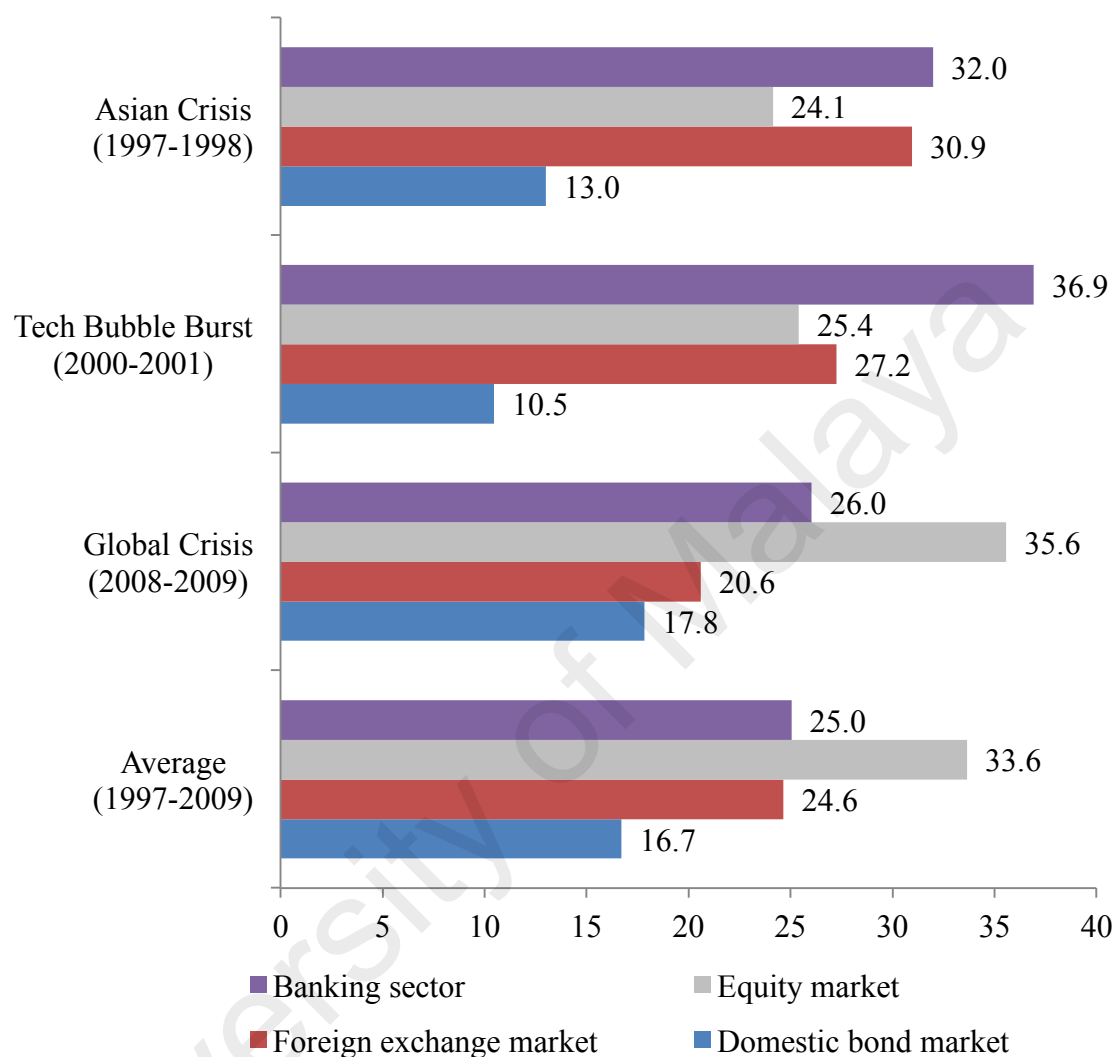
Note: Periods corresponding to the AFC, tech burst and GFC are 1997-1998, 2000-2001 and 2008-2009. Episodes that overlap with these periods before start or after the end dates are counted as the same episode.

A total of 33 stress episodes occurred across all 5 sample countries over the period studied. On average, each country experienced between 6-7 episodes each lasting 7 months long, although the duration is skewed by the AFC. Singapore experienced the highest number of episodes, 9, although the episodes also subsided the quickest; the opposite is true for Malaysia with only 4 episodes each lasting an average of 10.3 months. Aside from the three aforementioned notable financial episodes, the sample countries also experienced other more minor episodes. This reflects the fact that although financial stress episodes tend to possess regional (e.g. AFC) or global (e.g. GFC, tech bust) characteristics, idiosyncratic country-specific factors can also trigger higher stress in domestic financial markets. Nonetheless, the results suggest that such country-specific episodes tend to be relatively minor in amplitude and duration, especially when they remain isolated.

### 3.3.2 A Historical Perspective of Financial Episodes

This section recasts the experiences of the ASEAN-5 economies during the AFC, tech bust and GFC, when there was a notable synchronicity in the peaks of the FSIs. Figure

3.6 provides a succinct summary of the distinctions of these episodes in terms of the sources of stress.



Source: Author's calculations

**Figure 3.6: Contribution of Market Segments to Overall Financial Stress across Financial Episodes (Share, %)**

Financial stress during the AFC episode was mainly attributable to stress in the banking sector and foreign exchange market, each contributing shares of 32.0% and 30.9% of overall financial stress. Using the financial crisis database by Laeven and Valencia (2008) as a reference, this is consistent with the literature that, with the exception of Singapore, the ASEAN-5 economies all suffered from banking and currency crises during this episode. The banking sector also contributed the highest share to the increase in financial



stress during the tech bust period (2000-2001), with a share of 36.9%. However, it is noted that in many cases, the ASEAN-5 banking system had either just completed or was in the midst of restructuring as financial stress had just started to normalise after the AFC. Financial stress among the ASEAN-5 economies during the GFC was driven overwhelmingly by stress in equity markets, whose contribution of 35.6% was substantially higher than the next highest share of 26.0% from the banking sector.

The remaining narrative is complemented by Figure 3.7 and Table 3.3. Figure 3.7 provides a measure of synchronisation of financial stress in the region, by depicting the proportion of countries that are under stress. Table 3.3 presents the dates of peaks in the individual market and overall FSIs during the periods specified. The lower panel of the table shows when global peaks occurred.

### **3.3.2.1 The AFC (1997-1998)**

Of the 3 financial episodes, financial stress during the AFC was by far the most severe. This episode lasted the longest, an average of 20.4 months, was the highest in magnitude, and encompassed stress in all markets. The crisis began with stress in foreign exchange markets after Thailand floated its Baht in July 1997 and peaked in late 1997. Stress in the banking sectors and foreign exchange markets emerged concurrently, but stress in banks generally lasted longer as the peaks in financial stress in most of the countries and the period when the stress subsided occurred after those from foreign exchange markets. Equity market stress intensified only in late 1997 as the crisis first spread from South East Asia to other developed Asian countries, then to the rest of the world (Sheng, 2009). Indeed, equity market stress in all countries peaked in the second half of 1998, often towards the end of the year, in the midst of turmoil in international financial markets, notably with the Russian crisis in August 1998 that prompted the collapse of Long Term Capital Management (LTCM) in the United States and a crisis in Brazil in September 1998 (Table 3.3). Thus, the FSIs depict the AFC as a twin banking and currency crisis

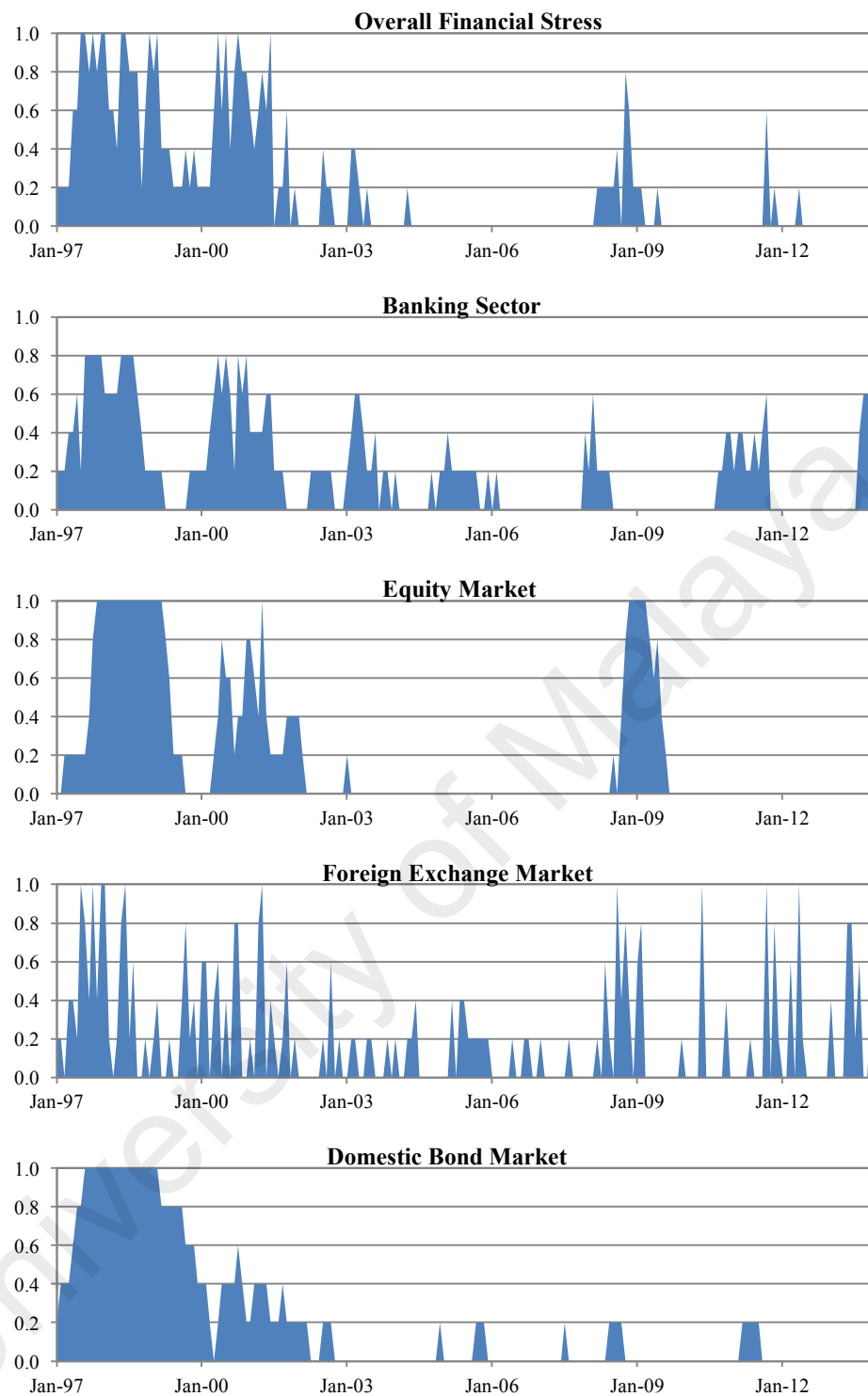
that ended with stress in equity markets as the crisis transformed from a regional to an international crisis. The peaks in the FSIs also seemed to coincide with key country specific events. Focusing on the 3 most impacted countries: Thailand's peak in August 1997 coincides with its agreement with the IMF on 20<sup>th</sup> August 1997 for a US\$17 million rescue package. Indonesia's peak in January 1998 occurred when its president signed the country's second agreement with the IMF on 15<sup>th</sup> January 1998 and the assets and liabilities of the country's incorporated banks were guaranteed (26<sup>th</sup> January). Malaysia's peak in January 1998 occurred as its ringgit fell to a record low and blanket guarantees on deposits were announced (20<sup>th</sup> January 1998). It is also worth noting that Malaysia's FSI spiked in October 1998 after a period of moderating financial stress shortly after capital controls (1<sup>st</sup> September) and a peg on the ringgit (2<sup>nd</sup> September) were surprisingly imposed in September 1998, with further clarification notices published throughout September and October by the central bank<sup>26</sup>.

### **3.3.2.2 The Tech Bust (2000-2001)**

Financial stress in the ASEAN-5 economies during this period lasted an average of 8.4 months. There is a large variation in the peaks of the FSIs during this episode, occurring as early as April 2000 in Thailand, as late as May 2001 in Malaysia and Singapore and in October 2000 in Indonesia and the Philippines. This period roughly corresponds with the tech bust in the US economy when large declines in technology related stock prices occurred, with the NASDAQ composite index falling by over 50% by the end of 2000 after peaking on 10<sup>th</sup> March 2000.

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<sup>26</sup> The clarification of the control measures are published on Bank Negara Malaysia's website.



Sources: Author's Calculations

**Figure 3.7: Proportion of Countries under Financial Stress**

**Table 3.3: Local and Global Peaks in Financial Stress**

	Bank	Equity	Foreign Exchange	Bond	Overall
<u><i>AFC &amp; LTCM Collapse (1997-1999)</i></u>					
Indonesia	Jun-98	Oct-98	Jan-98	Oct-98	Jan-98
Malaysia	Nov-97	Sep-98	Jan-98	Jun-98	Jan-98
The Philippines	Jan-98	Dec-98	Dec-97	Apr-98	Dec-97
Singapore	Sep-98	Nov-98	May-98	Sep-98	May-98
Thailand	Jul-98	Jul-98	Jul-97	Feb-98	Aug-97
<u><i>Technology Bubble Burst (2000-2001)</i></u>					
Indonesia	May-00	Apr-01	Sep-00	Jan-00	Oct-00
Malaysia	Jun-00	May-01	Mar-01	Jan-00	May-01
The Philippines	Nov-00	Jun-00	Oct-00	Nov-00	Oct-00
Singapore	Sep-00	Oct-01	Mar-01	Aug-00	Mar-01
Thailand	Apr-00	Jun-00	Mar-01	Jul-00	Apr-00
<u><i>GFC (2008-2009)</i></u>					
Indonesia	Jun-08	Nov-08	Oct-08	Sep-09	Nov-08
Malaysia	Feb-08	Nov-08	Sep-08	May-09	Oct-08
The Philippines	Jan-08	Nov-08	Oct-08	Jul-08	Oct-08
Singapore	Feb-08	Nov-08	Jan-09	Jul-08	Jan-09
Thailand	Jun-08	Nov-08	Jun-08	May-09	Nov-08
<u><i>Global Peaks</i></u>					
Indonesia	Jun-98	Oct-98	Jan-98	Oct-98	Jan-98
Malaysia	Nov-97	Sep-98	Jan-98	Jun-98	Jan-98
The Philippines	Jan-98	Dec-98	Dec-97	Apr-98	Dec-97
Singapore	Sep-00	Nov-98	Sep-11	Sep-98	May-98
Thailand	Jul-98	Jul-98	Jul-97	Feb-98	Aug-97

Source: Author's calculations

This episode is most related with stress in the banking sector, which started to increase in the second half of 1999, corresponding with the Russian Crisis and LTCM collapse and only intensified during the tech bust. Indeed, the majority of peaks in banking sector stress occurred after the NASDAQ peaked, when most of the declines took place.

### **3.3.2.3 The GFC (2008-2009)**

From the ASEAN-5's perspective, the FSIs portray the GFC as an external shock that was mostly contained within the equity market. This episode played out in two distinct phases. Financial stress first surfaced in the banking sector in the beginning of 2008 and persisted through the first half of the year as US and European banks began reporting losses from securities linked to subprime mortgage loans and were faced with severe liquidity shortages. For instance, the LIBOR-OIS spread, an indicator of the health of banks, rose from roughly 10 basis points in August 2007 to a historical high of 108 basis points by 6<sup>th</sup> December 2007 (Sengupta & Tam, 2008). Globally, there was uncertainty among banks about the amount of exposure they had to products linked to such subprime mortgage related loans. Among the ASEAN-5 economies, banking sector stress was the first source of stress to emerge, compared to the other market segments. In all cases, the local peaks during this episode occurred in the banking sector during the first half of 2008, before the local peaks in financial stress from the other asset markets<sup>27</sup> (Table 3.3). However, banking sector stress also tended to be brief and sporadic. At its peak, bank stress only surfaced in 3 out of the 5 sample countries for only a month before moderating.

The second phase encompassed stress in the foreign exchange and equity markets, and began in earnest in the second half of 2008 in the midst of a global flight to US Treasuries

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<sup>27</sup> The only exception is Thailand, where the local peak of financial stress in the banking sector occurred in the same month as financial stress in the foreign exchange market.

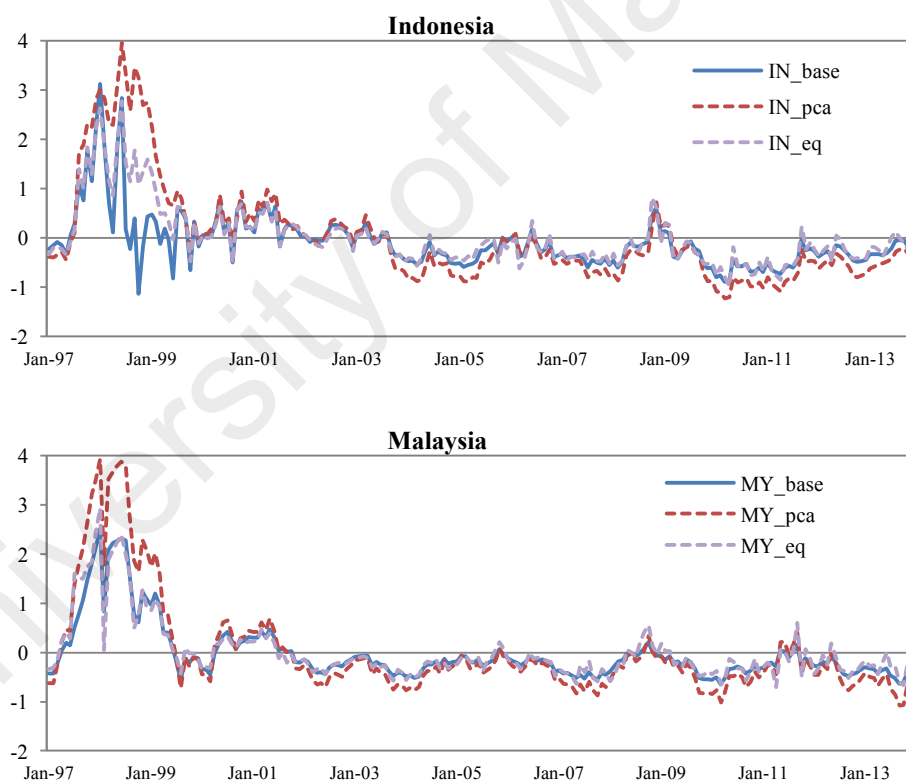
and a corresponding sell-off of emerging market assets. This phase played out during a tumultuous stage of the GFC which saw, among others, Lehman Brothers investment bank file for bankruptcy, Merrill Lynch sold to Bank of America and many other bank mergers and acquisitions, while the remaining US investment banks were transformed into bank holding companies. During this phase, financial stress tended to appear first in foreign exchange markets as the global flight to quality led to capital outflows which exerted depreciating pressures on the exchange rate, then spread to equity markets where the episode tapered off by the middle of 2009. Strikingly, equity market stress in all the sample countries peaked in November 2008, which strongly indicates that the GFC was a common shock for the ASEAN-5. Overall financial stress in the region peaked in conjunction with equity market stress.

### **3.4 Robustness of the FSIs to other Weighting Methodologies**

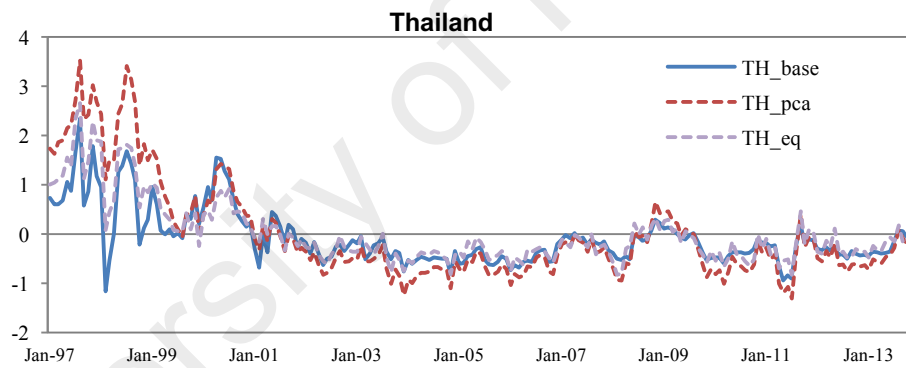
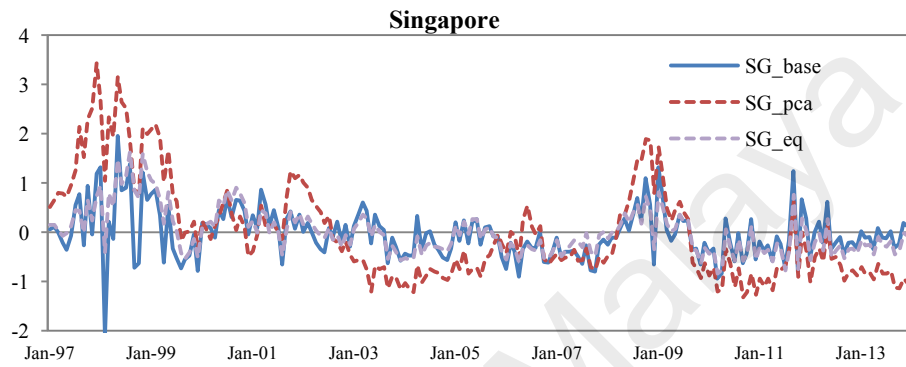
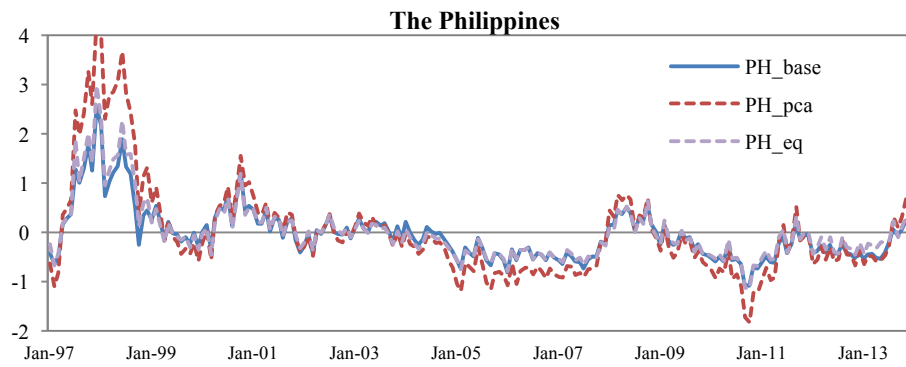
The narration of how financial stress has evolved from 1997 to 2013, including the interpretations of the magnitude and duration of financial stress during periods of known episodes, is premised on the choice of stress indicators and the weighting methodology. While the former is broadly in line with existing literature, the main departure is in the weighing methodology. As discussed earlier and in Chapter 2, a majority of the existing FSIs are weighted either using equal weights or loadings from the first principal component. Ultimately, the different weighting options lend to differences in interpretation with no clear guidance on which is the best. Applying the economy's financial structure as a guide, as done in the baseline construction, makes the most intuitive sense as financial stress in larger and more important markets are given larger weights. Using a principal component methodology is premised on financial stress being the underlying factor driving the common variation among all the stress indicators. Meanwhile, applying equal weights avoids having to place judgement and assumes all indicators are equally valid contributors of overall financial stress. Due to this lack of

clarity on the relative superiority of the various weighting methodologies, it is best to compare the performances of the FSIs constructed with alternative weighting methods, as illustrated in Figure 3.8.

A comparison of the FSIs with the three weighting methodologies reveals that the index performances are qualitatively similar. The AFC remains the most severe, followed by the tech bust and the GFC. The largest departure is from the FSI constructed from principal components. The principal component analysis based FSIs depicts the ASEAN-5 economies as experiencing higher and longer duration of financial stress during the AFC episode. All other key findings remain similar.



**Figure 3.8: Comparison of FSIs with Alternative Weighting Methodologies**



Sources: Author's Calculations

Notes: "base" refers to baseline methodology where the financial structure weights are used, "pca" are principal component based weights and "eq" refers to equal weights. "IN", "MY", "PH", "SG" and "TH" denote Indonesia, Malaysia, the Philippines, Singapore and Thailand, respectively.

**Figure 3.8: Continued**



### **3.5 Conclusion**

This chapter develops a methodology to measure financial stability conditions in the ASEAN-5 economies on a continuous scale, through the construction of indices called Financial Stress Indices (FSIs). Market specific FSIs are constructed to measure financial stress in the banking sector, equity market, domestic bond market and foreign exchange market, while overall FSIs are constructed to measure systemic financial stress in the broader financial system. The overall FSIs are weighted averages of the market FSIs, with the weights reflecting the relative sizes of markets represented by the market FSIs.

The FSIs show that financial stress during the AFC was most severe, both in duration and magnitude, followed by the tech bust and the GFC. These findings are robust across all sample countries, except for Singapore, where the GFC was more severe in amplitude compared to the tech bust. A decomposition of the contribution of overall financial stress by asset markets reveals that the AFC encompassed stress mainly from the foreign exchange market and banking sector. In contrast, stress during the GFC emerged first in the banking sector and subsequently moved on to equity and foreign exchange markets where the majority of stress during this episode was felt.

## CHAPTER 4 : SOURCES OF MACRO-FINANCIAL VULNERABILITIES IN ASEAN-5 ECONOMIES<sup>28</sup>

### 4.1 Introduction

The standard narrative from the literature on the Early Warning Indicators (EWI) of financial crises is that crises usually occur as economic growth starts to slow after a sustained period of high growth, loose credit conditions and over-valued asset prices<sup>29</sup>. While the findings are robust, they pertain only to crisis and do not provide a complete explanation of the entire financial cycle and of macro-financial vulnerabilities. This is true especially in small-open economies where financial conditions are also susceptible to spillovers from external sources. While such financial market disruptions do not always reach crisis proportions, they are often severe enough to have material adverse growth effects and, hence, warrant attention as well. For example, using a sample of 21 Asian economies, Hong *et al.* (2010) show that domestic financial stress often coincided with stress in major financial centres and that all financial episodes were associated with growth slowdowns.

Against this backdrop, this chapter investigates the determinants of financial stress throughout the entire financial cycle, instead of just crisis periods, for 5 small-open economies - Indonesia, Malaysia, the Philippines, Singapore and Thailand (ASEAN-5). Drawing on recent studies by Balakrishnan *et al.* (2011), Duca and Peltonen (2011) and Park and Mercado Jr (2014), this chapter uses the Financial Stress Indices (FSIs) from

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<sup>28</sup> Findings from this chapter were presented at the 2014 Joint Meetings of the Australian Conference of Economists and Econometric Society Australasian Meetings (ESAM) in Tasmania, Australia, the 2014 ISI Regional Statistics Conference in Kuala Lumpur, Malaysia, and the Bank of Thailand and Bank for International Settlements (BoT-BIS) 8<sup>th</sup> Annual Workshop of the Asian Research Networks 2015.

<sup>29</sup> Kaminsky and Reinhart (1999) and Borio and Lowe (2002) are early influential studies.

Chapter 3 to estimate quarterly panel regressions of financial stress. Financial stress is modelled as a function of common global variables, regional financial contagion and country-specific indicators of financial vulnerability.

This chapter makes four contributions to existing panel models of financial stress: First, regional financial contagion is measured explicitly to be in line with the financial contagion literature. Second, an Instrumental Variable (IV) approach is used to estimate the panel model of financial stress, using lags of the domestic variables as instruments, to address endogeneity issues between financial stress and the explanatory variables. Third, using the overall FSIs, the panel analysis investigates the determinants of systemic financial stress and the role of trade and financial linkages in facilitating the transmission of external financial shocks to financial stress in the ASEAN-5 economies. Fourth, the panel analysis is conducted on the market-specific FSIs (representing stress in the banking system, equities, foreign exchange and bond market), to investigate if the sources of financial stress are similar across asset markets and to give insight to how financial stress spreads from individual asset markets to other asset markets.

Using the FSIs offer two advantages: First, the FSIs facilitate an analysis of the financial cycle during tranquil and stressful periods in financial markets, as they are continuous measures of financial stress. This offers an advantage over the approach used in the EWI literature, where judgement is required to date and identify crises, which then take on binary states - crisis or no crisis. As such, the FSIs are useful for analysing the determinants of financial stress in countries with few historical incidences of financial crises, such as the ASEAN-5 economies. Secondly, the FSIs provide a consistent bottom-up methodology to measure financial stress starting at the level of individual asset markets, which are then aggregated to reflect systemic financial stress. This facilitates

analyses of financial stress at the systemic and individual asset market levels within a common measurement framework.

The results find that both external and domestic variables play significant roles in driving financial stress in the ASEAN-5 economies. Among the common variables, US financial stress and regional financial contagion are consistently significant across model specifications and estimation methodology. Bank credit is the only domestic determinant that was consistently significant, with a positive bank credit gap foreshadowing higher financial stress. While it was difficult to pin down the roles of trade and financial linkages in the transmission from external to ASEAN-5 financial stress, strong external banking sector ties - borrowings by residents from external banks and foreign bank subsidies on domestic shores - is associated with higher stress transmission across borders. Panel regressions of market specific sources of financial stress showed the importance of the domestic banking system and equity market for all other markets. High stress in either market is significantly associated with higher financial stress elsewhere. In particular, the results reflect a vicious cycle of stress transmission between the banking system and equity markets. Adverse conditions in either exacerbates stress levels in the other, which in turn worsens the originating source of stress, and so on.

The remaining sections in this chapter proceed as follows. Section 4.2 presents the data used for the analysis. This includes how the variables are constructed and stylised observations of the variables. Section 4.3 details the panel model. Section 4.4 presents the baseline results. Section 4.5 examines the role of trade and financial linkages. Section 4.6 investigates the presence of two-way causality between financial stress and the explanatory variables, and re-estimates the panel model through an IV methodology. Section 4.7 examines the sources of financial stress within individual asset markets. The final section concludes with the main findings.

## 4.2 Data

The dataset consists of 5 ASEAN countries: Indonesia, Malaysia, the Philippines, Singapore and Thailand. The series are in quarterly frequency and span from 1997-2013. To uncover the sources of financial stress for the ASEAN-5 economies, the analysis starts with a broad set of variables as candidates. These variables are drawn from the EWI literature<sup>30</sup> and more recent studies that attempt to explain the sources of financial cycles using the FSIs<sup>31</sup>. Table 4.1 lists the variables and their sources. The dependent variable is the Financial Stress Index (FSI) for the ASEAN-5 economies from Chapter 3 and Tng *et al.* (2012). Since the panel regressions are in quarterly frequency, the FSIs are converted from monthly to quarterly frequency by averaging the monthly values within each quarter. The independent variables consist of common external, regional and country-specific domestic variables.

There are four external variables: World Gross Domestic Product (*GDPw*) captures global economic conditions; a weighted index of primary commodity prices (*GCP*) to measure the global price level; a FSI of the United States (US) (*FSIus*) from Hakkio and Keeton (2009), which proxies for global financial conditions<sup>32</sup>. The last common variable, *Cont.*, measures regional financial contagion. The next section details the methodology to construct this variable.

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<sup>30</sup> Kaminsky and Reinhart (1999) and Borio and Lowe (Borio & Lowe, 2002) are early influential studies.

<sup>31</sup> For instance, Balakrishnan *et al.* (2011), Misina and Tkacz (2009), Duca and Peltonen (2011) and Park and Mercado Jr (2014).

<sup>32</sup> This index is quantitatively similar to other FSIs of the US economy in the literature, for instance, by Cardarelli *et al.* (2011) from the IMF and Kliesen and Smith (2010) from the Federal Reserve Bank of St. Louis.

**Table 4.1: List of Variables for Panel Estimation**

Variable	Abbreviation	Definition	Source
<b>Dependent Variable</b>			
<i>ASEAN-5 Financial Stress</i>	<i>FSI</i>	Financial Stress Index	Tng <i>et al.</i> (2012), Chapter 3
<b>Independent variables</b>			
<b><u>Global variables</u></b>			
<i>World Real Gross Domestic Product</i>	<i>GDP<sub>w</sub></i>	World Real GDP (log, sa)	World Bank
<i>Commodity Prices</i>	<i>GCP</i>	IMF Primary Commodity Price Index (log, sa)	International Monetary Fund
<i>US Financial Stress</i>	<i>FSI_US</i>	US Financial Stress Index	Hakkio and Keeton (2009)
<b><u>International Trade and financial linkages</u></b>			
<i>Export exposure</i>	<i>EX</i>	Exports/GDP (deflated)	Haver Analytics
<i>Bank</i>	<i>FL<sub>bank</sub></i>	Consolidated foreign claims of BIS reporting banks/ GDP	Bank for International Settlements
<i>Direct investment</i>	<i>FL<sub>FDI</sub></i>	External portfolio liabilities/GDP	International Financial Statistics (IFS), Haver Analytics
<i>Portfolio</i>	<i>FL<sub>PL</sub></i>	External portfolio liabilities/GDP	IFS, Haver Analytics
<b><u>Regional variable</u></b>			
<i>Regional Contagion</i>	<i>Cont</i>	See section 1.3	Author's calculations
<b><u>Country Specific Variables</u></b>			
<i>Real Gross Domestic Product</i>	<i>GDP</i>	Real GDP (log, sa, 2005=100)	World Bank
<i>Real Bank Credit</i>	<i>Credit</i>	Domestic bank credit, deflated by CPI	IFS, Haver Analytics
<i>Current Account</i>	<i>CA</i>	Ratio of GDP (sa, %)	Haver Analytics
<i>Foreign Reserves</i>	<i>Res</i>	Ratio of GDP (sa, %)	IFS, Haver Analytics
<i>Fiscal Balance</i>	<i>FB</i>	Ratio of GDP (%)	Haver Analytics

Note: “log” and “sa” refer respectively to natural logarithm and seasonal adjustment (using the X12 seasonal adjustment procedure). Real GDP and Bank Credit are indexed to 2005=100.

Five domestic variables are considered as potential sources of financial stress: *Real GDP* reflects domestic economic conditions; *Credit* captures domestic bank credit. The current account balance, international reserves and the fiscal balance are variables that reflect

various facets of structural imbalances and policy space, and are thus considered as potential triggers of financial stress as well.

The variables are initially tested for stationarity using the Im, Pesaran, and Shin (2003) (IPS) panel unit root test. These tests are conducted on the variables in levels and de-trended using the Hodrick-Prescott (HP) filter (Table 4.2). This method of de-trending follows from Borio and Lowe (2002), Cardarelli *et al.* (2011) and Duca and Peltonen (2011). An economic reason for applying a time-varying filter instead of taking the first difference to de-trend the variables is that it removes country-specific changes in financial market development and how economic agents utilise financial markets to facilitate real economic activity. Cardarelli *et al.* (2011) thus refer to this method of de-trending as a “time-varying fixed-effect” which facilitates cross-country analysis. All variables are stationary after HP de-trending. Variables that are not stationary in levels with statistical significance below 5% are de-trended for the panel estimations.

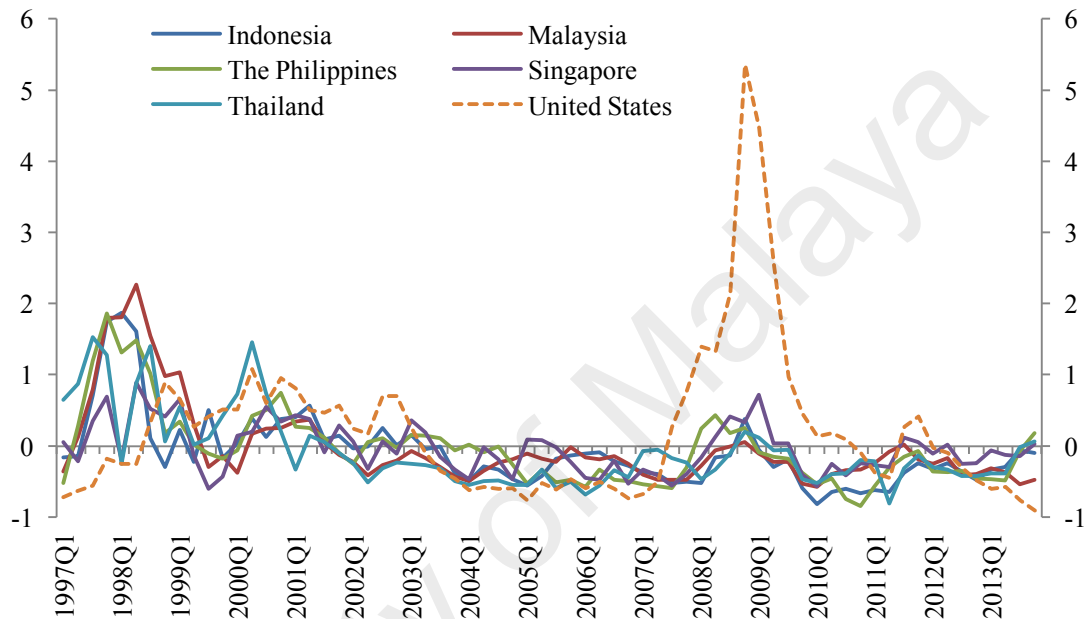
**Table 4.2: Panel Unit Root Test Results (*P*-Value)**

		Levels	Gap (HP filtered)	De-trend in panel model
Dependent variable	<i>FSI</i>	0.00	0.00	no
External variables	<i>World GDP</i>	0.96	0.00	yes
	<i>Commodity prices</i>	0.98	0.00	yes
	<i>US Financial Stress</i>	0.00	0.00	no
	<i>Contagion</i>	0.00	0.00	no
Domestic variables	<i>GDP</i>	1.00	0.00	yes
	<i>Bank credit</i>	1.00	0.00	yes
	<i>International reserves</i>	0.00	0.00	no
	<i>Current account</i>	0.00	0.00	no
	<i>Fiscal balance</i>	0.00	0.00	no
Trade & Financial linkages	<i>Export dependence</i>	0.00	0.00	no
	<i>Bank linkages</i>	0.01	0.00	no
	<i>Portfolio linkages</i>	0.39	0.00	yes
	<i>Direct investment linkages</i>	0.59	0.00	yes

Notes: The null hypothesis is the variables have a unit root. The alternative hypothesis is some of the series are stationary. The values in the table are p-values. The specifications include a constant. Lags are optimally selected using the Schwarz Information Criterion (SIC).

#### 4.2.1 Stylised Facts

Prior to estimating the panel model, it is useful to begin by analysing the behaviour of the variables over time and compared with ASEAN-5 financial stress to establish *ex ante* expectations about the potential relationships. Figure 4.1 illustrates financial stress in the ASEAN-5 economies alongside financial stress in the US.



Source: Tng *et al.* (2012) and Hakkio and Keeton (2009)

Note: The US FSI was standardised using calculations of the mean and standard deviation from the sample period 1997-2013, similar to the ASEAN-5 FSIs, to equalize the units of measurement to facilitate ease in comparison.

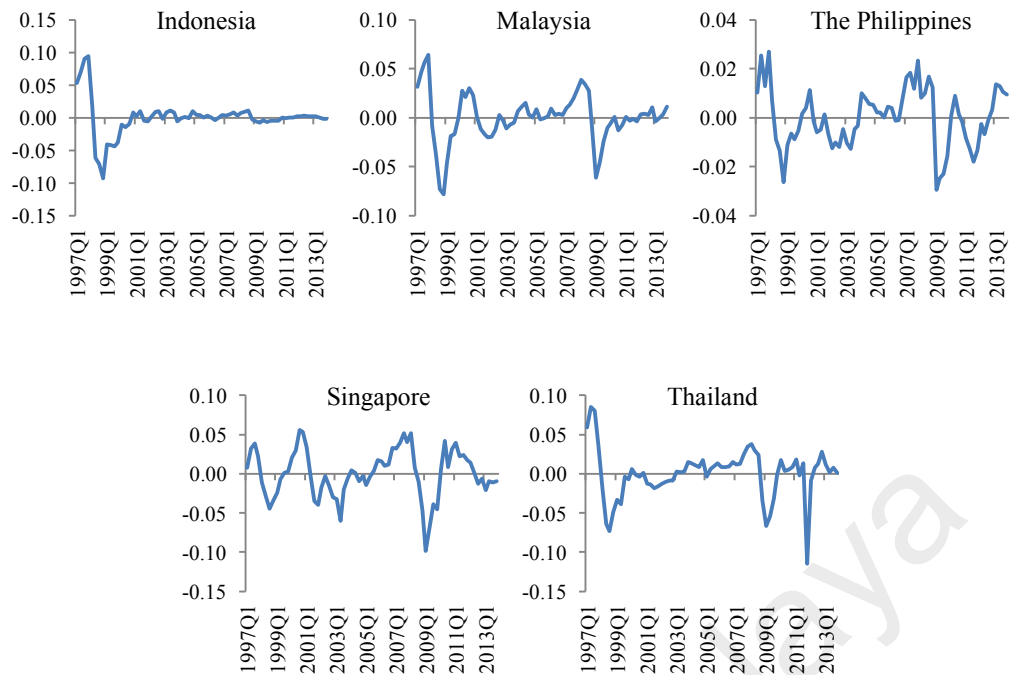
**Figure 4.1: Financial Stress in the ASEAN-5 Economies and United States**

Three observations stand out: First, the Asian Financial Crisis (AFC) in 1997-1998 for the ASEAN-5 economies was a substantially less severe financial event, compared to the Global Financial Crisis (GFC) in 2008-2009 for the US economy. This is gleaned from the level of the FSIs during these episodes - the FSIs for the ASEAN-5 during the AFC period tended to peak at around 2 standard deviations while the US FSI peaked at 6 standard deviations during the GFC period. Secondly, financial stress in the US economy rose to substantially higher levels during the GFC compared to its technology bubble



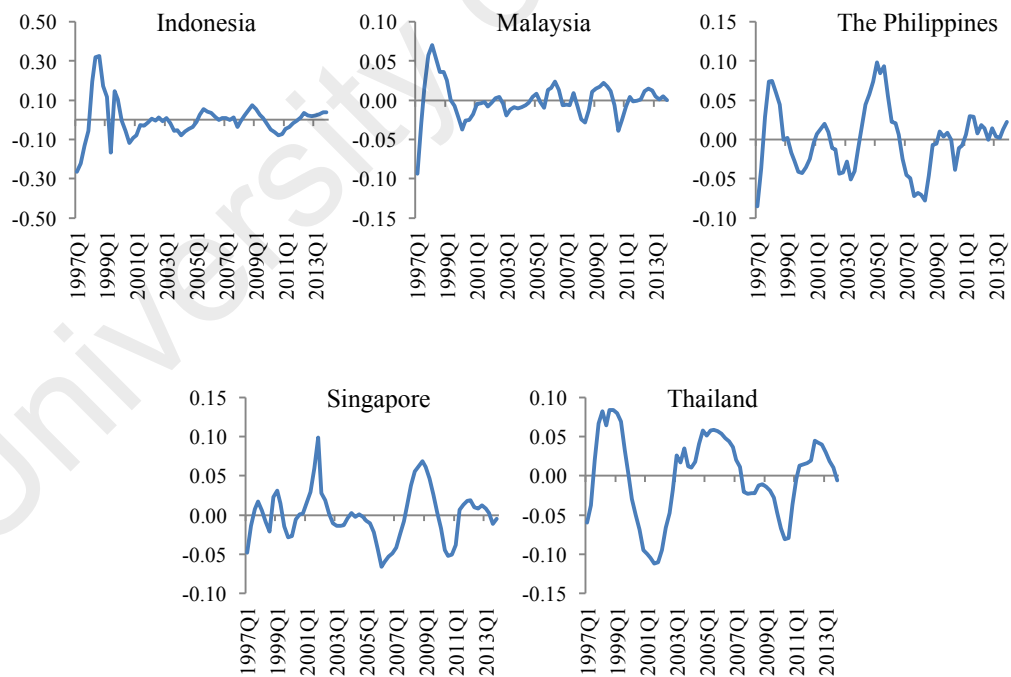
burst (tech bust) episode in 2000-2001. However, financial stress among the ASEAN-5 economies did not display a corresponding increase in financial stress across these two episodes. Except for Singapore, the ASEAN-5 FSIs rose to higher levels during the tech bust period compared to the GFC period, implying that ASEAN-5 financial markets withstood the GFC episode much better than the tech bust shock. Third, while there are clear distinctions between the US FSI and the ASEAN-5 FSIs, there seems to be a high degree of co-movement among the ASEAN-5 FSIs. This suggests strongly that regional level financial contagion plays an important role in stress transmission for the individual ASEAN-5 economies, and is a hypothesis that will be tested in this chapter.

Figure 4.2 presents the output gap for the ASEAN-5 economies, which shows that higher financial stress tends to be preceded by positive output gaps, followed by movement toward negative output gaps as financial stress increases. This was especially the case for the AFC episode and the GFC to a smaller extent. Figure 4.3 displays the domestic credit gap. In contrast with the output gap, the credit gaps across the ASEAN-5 display a more heterogeneous pattern. The only consistent development across countries was the large positive gap during the AFC period. This was observed in all sample economies except in Singapore. Incidentally, Singapore was the economy whose level of financial stress was the lowest as its peak during the AFC period. Indeed, the presence of large credit gaps during the AFC period and the consistent lack of such gaps during the tech bust and GFC periods suggest that this is a reason the ASEAN-5 economies experienced much lower financial stress during the latter two episodes (tech bust and GFC) - there was a lack of excesses in the domestic banking system during key periods of larger external financial shocks.



Source: Author's calculations

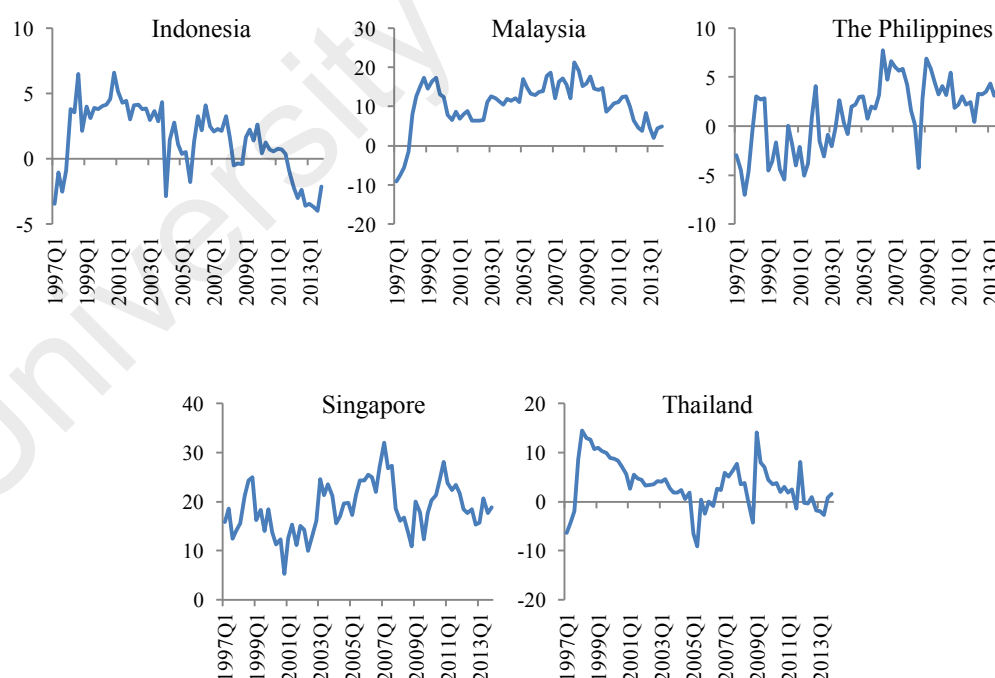
**Figure 4.2: Domestic Output Gaps in the ASEAN-5 Economies**



Source: Author's calculations

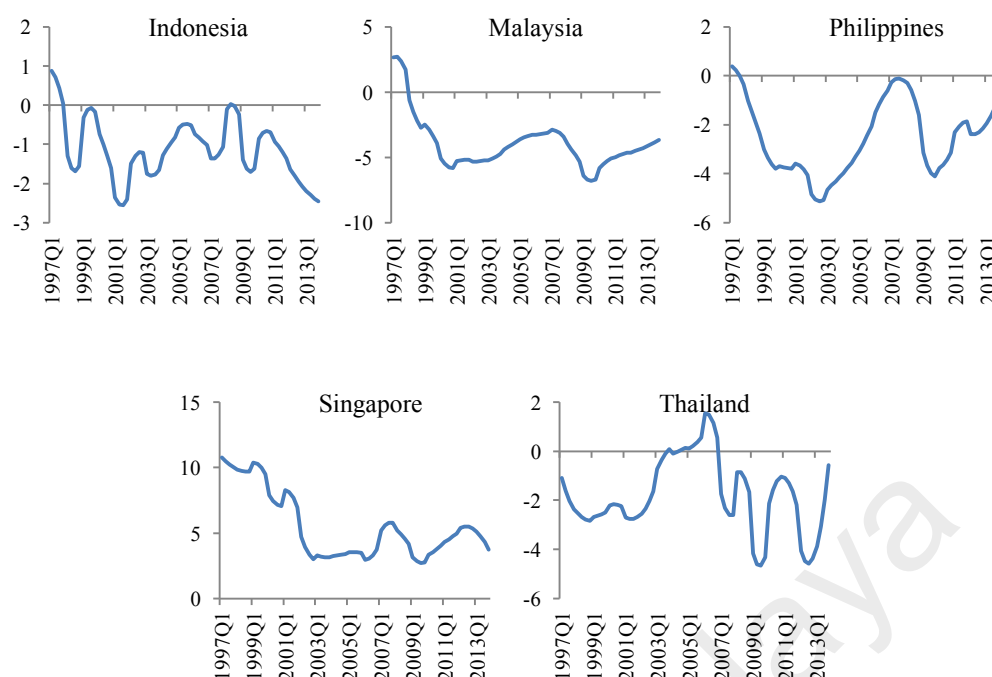
**Figure 4.3: Domestic Bank Credit Gaps in the ASEAN-5 Economies**

Figure 4.4 and Figure 4.5 show two facets of structural vulnerabilities, through the current account and fiscal balances. Trends on the current account balance are relatively mixed. In Indonesia, Malaysia and Thailand, the balances improved substantially after the AFC, but experienced differing trends thereafter. In Malaysia, the positive balance remained relatively constant until the GFC episode, after which it has been on a moderating trend. In Indonesia, the balance also declined especially after the GFC episode, and experienced a negative balance since the fourth quarter of 2011. Singapore's balance displays a relatively cyclical trend with a gradual upward sloping trend over the longer-run. The balances in Thailand and Indonesia have evolved in a similar pattern. It was negative prior to the AFC, increased to surplus levels after the crisis and deteriorated gradually since then to become negative again by the fourth quarter of 2011. The balance in the Philippines is the smallest on average throughout the sample period, indicating that it possesses the most internal-external balance compared to the other sample economies.



Source: Author's calculations

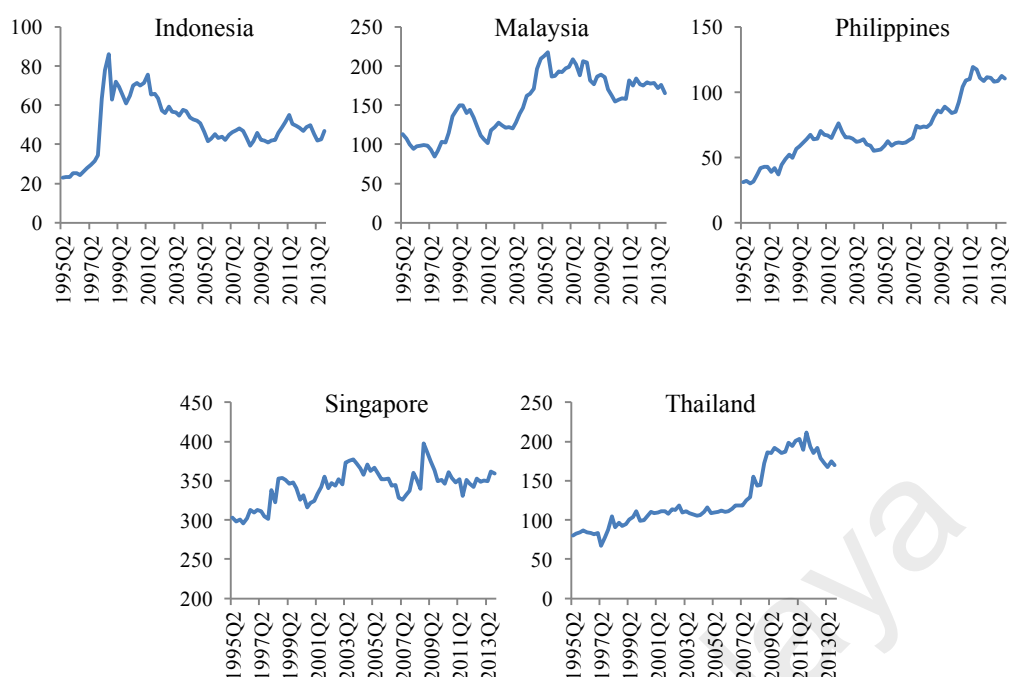
**Figure 4.4: Current Account Balance in the ASEAN-5 Economies (% of GDP)**



Source: Author's calculations

**Figure 4.5: Fiscal Balances in the ASEAN-5 Economies (% of GDP)**

Fiscal balances were generally positive before the AFC, except in Thailand who had a small deficit, but uniformly deteriorated during the AFC period. The balances then gradually showed signs of stabilisation and improvements from 2000-2001 until the GFC episode when expansionary fiscal policies resulted in lower fiscal balances again. Similar to the current account dynamics, the fiscal balances also feature substantial country-specific behaviour. The final country-specific indicator of financial vulnerability is international reserves. With the exception of Indonesia, international reserves as a percentage of GDP have generally been on an increasing trend over the period shown (1997-2013) (Figure 4.6). Thus, the higher level of international reserves may also be a contributing factor to the improved resilience of domestic financial stress to external shocks, as it indicates added policy space to finance foreign currency commitments (for instance, imports and external debt) during crises.



Source: Author's calculations

**Figure 4.6: International Reserves (Excluding Gold) in the ASEAN-5 Economies (% of GDP)**

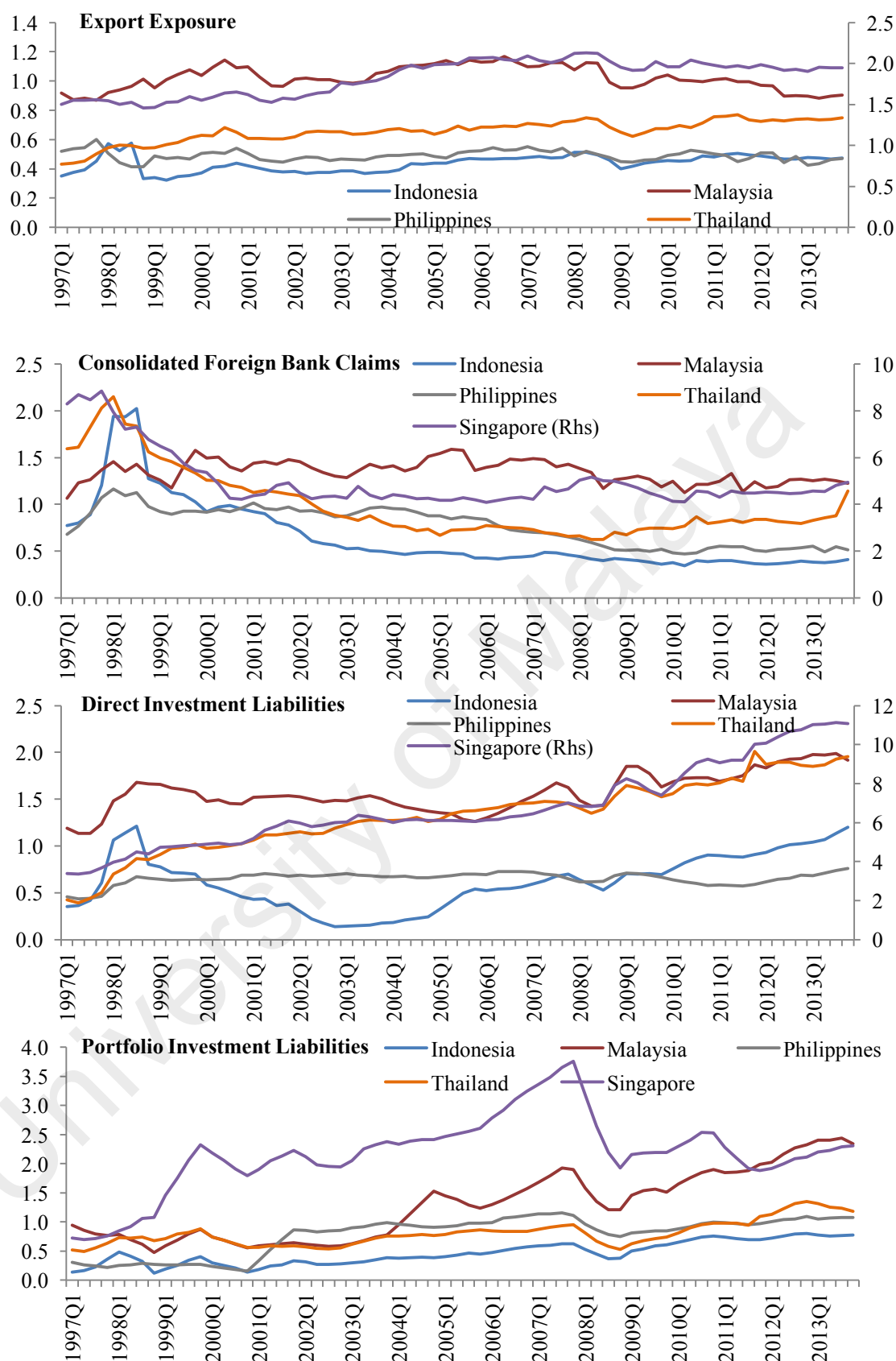
The stylised facts illustrated thus far suggests that over-heating domestic economic conditions, loose credit and the aforementioned financial vulnerabilities predispose economies to a higher likelihood of leading to a financial crisis. Another element of financial stress transmission for open-economies is the link with other markets, as these linkages can absorb or exacerbate the initial financial shocks.

Figure 4.7 shows trade and three financial linkages - bank, direct investment and portfolio investment - for the ASEAN-5 economies. For trade linkages, shown as the export to GDP ratio, Singapore emerges as a highly export dependent economy, with the ratio increasing progressively from an already high level in 1997 to 2013. Malaysia is the second most export dependent, although this dependency has been on a declining trend since 2009, in conjunction with the GFC episode. Thailand is the next most exposed with

the exposure increasing gradually over time, while the Philippines and Indonesia display broadly similar degrees of trade exposure.

Financial linkages are measured through banking, portfolio and direct investment linkages. There are three notable observations: First, there has been a declining trend in resident borrowings from foreign banks and their local affiliates for financing. Second, there is an increase in external portfolio liabilities over time. Both of these trends imply that while the ASEAN-5 economies have become less vulnerable to disruptions in the international credit cycle, their gradual progress to open and develop their own capital markets have made them more exposed to disturbances in global capital markets through increased portfolio investment flows, which can exhibit bouts of higher volatility. Third, the trends in foreign direct investment linkages across countries is more eclectic. This likely reflects country and industry-specific motivations for foreign firms' choices to invest in the individual ASEAN-5 economies. The FDI linkage in Singapore is the highest and has continued to increase over the sample period. This linkage has also increased over time in Thailand. In Malaysia, the FDI linkage declined post-AFC, remained roughly constant from 2000-2005 and has been on an increasing trend since then. The recent uptrend in the FDI stock to GDP ratio is also visible for Indonesia.

Thus, the trade channel remains ever present with little significant changes over time. For cross-border financial linkages, the region has pared down exposure to external bank credit, but the gradual development and opening of capital markets has resulted in higher foreign participation in domestic debt and equity markets. Singapore's trade and financial linkages are the most extensive with ratios that exceed the other ASEAN-5 economies over most of the sample period, which is not surprising given its position as a trading hub and financial centre.



Source: Author's calculations, Haver, Bank for International Settlements

**Figure 4.7: Trade and Financial Linkages in the ASEAN-5 Economies (Ratio of GDP)**

### 4.3 The Panel Model

This section presents the panel model that is estimated to assess the determinants of financial stress for the ASEAN-5 economies. Following Balakrishnan *et al.* (2011), Misina and Tkacz (2009), Duca and Peltonen (2011) and Park and Mercado Jr (2014), this model captures three main sources of financial stress - common external factors, regional financial contagion and country-specific sources.

The baseline panel model is presented in equation 4.1:

$$FSI_{it} = \alpha_i + \sum_{g=1}^3 \beta^g EF_t^g + \gamma Cont_t + \sum_{l=1}^4 \mu^l Dom_{it}^l + \varepsilon_{it} \quad (\text{Equation 4.1})$$

The dependent variable,  $FSI$ , is the Financial Stress Index for each ASEAN-5 economy.  $EF$  is a vector of three global variables - world Gross Domestic Product ( $GDP_w$ ), commodity prices ( $GCP$ ) and US financial stress ( $FSI_{US}$ ).  $FSI_{US}$  is taken as a proxy of global financial conditions.  $Dom$  is a vector of five domestic country-specific variables - Gross Domestic Product ( $GDP$ ), domestic bank credit ( $Credit$ ), the current account balance ( $CA$ ), international reserves ( $Res$ ) and the fiscal balance ( $FB$ ).  $\alpha_i$  is a time constant variable.

Finally,  $Cont$  is a measure of regional financial contagion. Financial contagion is defined various ways in the literature<sup>33</sup>. This analysis uses the World Bank's "restrictive" definition of contagion as a guide. This definition refers to contagion as the transmission of shocks to other countries for reasons that are not attributable to fundamentals or

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<sup>33</sup> The World Bank definitions of contagion is available here:

<http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTPROGRAMS/EXTMACROECO/0,,contentMDK:20889756~pagePK:64168182~piPK:64168060~theSitePK:477872,00.html>



common sources<sup>34</sup>. This suggests that regional contagion is empirically reflected as cross-country co-movement in financial market variables after controlling for fundamentals and global shocks. Accordingly, *Cont* is estimated in two steps. First, regressions equivalent to (1), but without *Cont*, are estimated for each ASEAN-5 economy. The residuals from these five regressions are saved and interpreted as unaccounted movements in financial stress in each country<sup>35</sup>. Secondly, the common co-movement among these residuals is interpreted as a reflection of financial contagion. To identify this common factor, Principal Component Analysis (PCA) is conducted on the residuals. Specifically, eigenvectors (loadings) from the first principal component are obtained. The loadings are then used as weights for the residuals from step 1 to construct an index of financial contagion among the ASEAN-5 economies. The index is presented in Figure 4.8 with more detailed results from the principal component analysis shown in Appendix B. The index spiked to its highest level during the AFC period and, to a smaller extent, during the US tech bust in 2000-2001. Interestingly, regional contagion remained relatively low throughout the GFC episode.

The panel model is estimated without cross-section fixed effects as joint significance tests of the null hypothesis that the restrictions are redundant could not be rejected<sup>36</sup>. The standard errors used are robust to serial correlation and heteroskedasticity. This analysis is most analogous to the annual panel model in Balakrishnan *et al.* (2011), but differs in several notable aspects. First, there are more country-specific explanatory variables, notably domestic GDP and bank credit. The latter, in particular, consistently emerges as

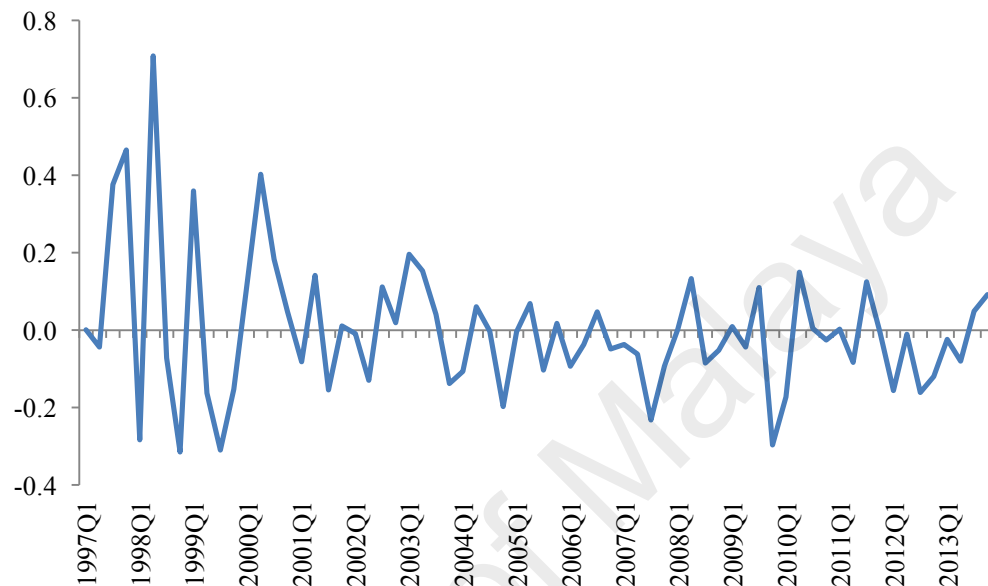
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<sup>34</sup> This approach of stripping away variations in financial variables is also used, among others, in Hatzius *et al.* (2010) and Balakrishnan *et al.* (2011).

<sup>35</sup> In this case, the decision on whether to use the variables in levels or gap terms is premised on the Phillips-Perron unit root test.

<sup>36</sup> The associated *F* and  $\chi^2$  statistics are 0.272 (*P*-value of 0.896) and 1.12 (*P*-value of 0.891).

a significant indicator of financial crisis/stress in related literature. Misina and Tkacz (2009) and Duca and Peltonen (2011) are two recent examples who use FSIs as their dependent variable. In both cases, bank credit is a statistically significantly predictor of financial stress. These findings are robust across most model specifications and countries.



Source: Author's calculations

**Figure 4.8: Measure of ASEAN-5 Regional Financial Contagion**

Second, financial contagion is measured more rigorously compared to other existing panel studies in the FSI literature. Balakrishnan *et al.* (2011) aggregate all the emerging economy FSIs except the dependent variable FSI and strip away variations that are attributable only to external factors (global industrial production, 3-month LIBOR, commodity prices and an index of financial stress for the advanced economies). Park and Mercado Jr (2014) measure regional effects by excluding the country under study. In contrast, this analysis strips away variations at the country level that is attributable to global and domestic determinants. Furthermore, the resulting residuals are aggregated using a methodology that is consistent with the financial contagion literature, as information on their co-movement is extracted using PCA.

Third, the model is estimated in quarterly instead of annual frequency. In addition to increasing the number of observations, the higher frequency allows for the inclusion of variables that may affect financial stress transmission with varying frequency ranges. For example, the role of financial channels such as portfolio rebalancing and herd behaviour in the transmission of financial stress from the US to the ASEAN-5 economies is likely better captured in higher frequency, while more fundamental determinants such as bank credit, the current balance or international reserves may determine domestic financial stress at relatively lower frequencies.

Finally, this analysis complements the analysis on the determinants of overall financial stress with a similar analysis but within individual asset markets. This is done to see if market specific financial stress responds symmetrically to the variables considered and also to characterise how financial stress spills over across markets.

#### **4.4 Baseline Estimation Results**

Table 4.3 presents results from five permutations of equation (1). Specification 1 shows results from a model with only the global and regional variables; Specification 2 presents results from only the domestic variables; Specifications 3 and 4 includes all external variables and different combinations of the domestic variables; Specification 4 includes all the variables.

Of the three global variables considered, US financial stress is consistently positive and statistically significant. This supports the view that because the ASEAN-5 economies are relatively small and open, stability in their financial markets are significantly influenced by financial conditions in major financial centres. Regional financial contagion, *Cont*, is also significant in all specifications, which is consistent with Park and Mercado Jr (2014), who find that regional financial stress levels have a positive and significant impact on domestic financial stress.

**Table 4.3: Baseline Panel Regression Results**

Dependent Variable	1	2	3	4	5
Financial Stress					
<i>World GDP</i>	2.653 (0.165)		2.023 (0.369)	2.379 (0.143)	1.817 (0.428)
<i>Commodity prices</i>	-0.246* (0.064)		0.004 (0.980)	-0.273*** (0.007)	0.011 (0.929)
<i>US financial stress</i>	0.077*** (0.000)		0.077*** (0.000)	0.079*** (0.000)	0.076*** (0.000)
<i>Regional financial contagion</i>	1.409*** (0.000)		1.393*** (0.000)	1.385*** (0.000)	1.373*** (0.000)
<i>GDP</i>		-0.377 (0.876)	-0.294 (0.899)		-0.644 (0.815)
<i>Bank Credit</i>		2.087*** (0.001)	2.017*** (0.000)		1.975*** (0.000)
<i>International reserves</i>		-0.002 (0.274)		-0.001 (0.378)	-0.001 (0.296)
<i>Current account</i>		-0.001 (0.907)		0.000 (0.982)	0.000 (0.962)
<i>Fiscal balance</i>		0.012 (0.360)		0.009 (0.368)	0.008 (0.470)
<i>Constant</i>	-0.070*** (0.000)	0.118 (0.508)	-0.070*** (0.000)	0.037 (0.767)	0.049 (0.725)
Adjusted R <sup>2</sup>	0.268	0.059	0.312	0.271	0.316

Notes: Figures in parentheses are p-values. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% significance levels.

Of the five country-specific variables considered, only bank credit emerges as consistently significant. The positive sign of the coefficient indicates that loose credit conditions predispose financial markets to higher stress. This is consistent with recent findings from Misina and Tkacz (2009), Duca and Peltonen (2011) and Park and Mercado Jr (2014)<sup>37</sup>. The significant relationship between boom/bust credit cycles and financial

<sup>37</sup> The authors estimate many different permutations of their panel model. The results on the estimated coefficient of global GDP growth vary in statistical significance and the sign. Nonetheless, the estimated coefficient using emerging Asia as their sample, which is most similar to the ASEAN-5 sample in this study, is positive and statistically significant.

crises is also consistent with early warning indicator studies embodied, for example, by Kaminsky and Reinhart (1999) and Borio and Lowe (2002).

The remaining three macroeconomic vulnerability indicators - international reserves, the current account balance and fiscal balance - are consistently insignificant. Nonetheless, this does not necessarily negate their significance in reality. A likely reason for their insignificance in these estimations is that the vulnerabilities associated with these variables are important only as triggers of high financial stress episodes. Since the panel model is estimated over low and high levels of financial stress, these vulnerabilities are averaged out over two phases - as the vulnerabilities accumulate but are insignificant determinants of financial stress and at high stress levels as market participants reach a tipping point and suddenly deem these variables to be significant sources of vulnerabilities. Another plausible reason is that these variables have largely remained above “safe threshold levels” during most of the sample period under study.

#### **4.5 Trade and Financial Linkages in the Transmission of External Financial Shocks**

This section now examines the role of trade and three financial linkages - bank, portfolio and direct investment - in the transmission of external financial shocks to ASEAN-5 financial markets. To do so, consider the following expanded version of the baseline panel model:

$$FSI_{it} = \alpha_i + \sum_{g=1}^3 \beta^g EF_t^g + \sum_{h=1}^4 \omega^h FSI_{US} \times Link_t^h + \gamma Cont_t + \sum_{l=1}^4 \mu^l Dom_{it}^l + \varepsilon_{it}$$

(Equation 4.2)

Equation (4.2) is like equation (4.1), except that the trade and financial linkage variables are added as interactions with US financial stress. The results are presented in Table 4.4. Specifications 1-4 present results from individually considering the trade and financial

linkage variables. The last specification includes all the linkages together. The results show that none of the linkages are significant factors in propagating the transmission of external to domestic financial stress.

The seeming lack of empirical evidence of the presence of trade and financial linkages in propagating cross-border stress transmission may be because other variables in the model already capture these linkages. For instance, domestic and world GDP likely capture some aspect of trade and financial linkages. To test for this possibility, equation 4.2 is pared down to include only US financial stress, regional contagion and the trade and financial linkages variables, as shown in equation 4.3. Table 4.5 presents the results.

$$FSI_{it} = \alpha_i + \beta FSI\_US_t + \sum_{h=1}^4 \omega^h FSI\_US \times Link_t^h + \gamma Cont_t + \varepsilon_{it} \quad (\text{Equation 4.3})$$

When considered individually, the export, bank and direct investment channels are statistically significant with the expected positive association. When all the linkages are included together, only export and bank linkages are significant. However, the coefficient representing trade linkage, unexpectedly, becomes negative. Broadly, there is limited evidence for the role of trade and financial linkages in the transmission of financial stress across borders. However, the sensitivity of the regression results across model specifications highlights difficulties in empirically differentiating among the respective channels, a concern also echoed in Kaminsky and Reinhart (2000). Nonetheless, the significance of bank linkages is the most robust and consistent with Balakrishnan *et al.* (2011) who utilise a substantially larger number of economies in their study.

**Table 4.4: Panel Model with Trade and Financial Linkages**

<b>Dependent Variable</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Financial Stress</b>					
<i>World GDP</i>	1.832 (0.419)	1.743 (0.462)	1.767 (0.407)	1.858 (0.431)	1.340 (0.578)
<i>Commodity prices</i>	0.005 (0.971)	0.011 (0.928)	0.010 (0.937)	0.043 (0.693)	0.094 (0.509)
<i>US financial stress</i>	0.067** (0.024)	0.067*** (0.001)	0.082*** (0.004)	0.073*** (0.000)	0.105** (0.027)
<i>US financial stress x Trade link</i>	0.010 (0.719)				-0.063 (0.391)
<i>US financial stress x Bank link</i>		0.006 (0.520)			0.024 (0.267)
<i>US financial stress x Portfolio link</i>			0.028 (0.772)		0.076 (0.595)
<i>US financial stress x Direct investment link</i>				0.074 (0.363)	0.108 (0.370)
<i>Regional financial contagion</i>	1.373*** (0.000)	1.374*** (0.000)	1.372*** (0.000)	1.371*** (0.000)	1.372*** (0.000)
<i>GDP</i>	-0.623 (0.824)	-0.584 (0.837)	-0.647 (0.814)	-0.580 (0.837)	-0.437 (0.879)
<i>Bank Credit</i>	1.962*** (0.000)	1.955*** (0.000)	1.983*** (0.000)	1.996*** (0.000)	2.024*** (0.000)
<i>International reserves</i>	-0.001 (0.285)	-0.001 (0.278)	-0.001 (0.300)	-0.001 (0.296)	-0.001 (0.283)
<i>Current account</i>	0.000 (0.959)	0.000 (0.949)	0.000 (0.961)	0.000 (0.968)	0.001 (0.929)
<i>Fiscal balance</i>	0.008 (0.504)	0.008 (0.533)	0.008 (0.460)	0.008 (0.504)	0.007 (0.572)
<i>Constant</i>	0.050 (0.717)	0.051 (0.713)	0.050 (0.725)	0.048 (0.732)	0.052 (0.716)
<b>Adjusted R<sup>2</sup></b>	<b>0.314</b>	<b>0.314</b>	<b>0.314</b>	<b>0.315</b>	<b>0.310</b>

Notes: Figures in italics are *p*-values. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% significance levels.

**Table 4.5: Pared Down Panel Model with Trade and Financial Linkages**

<b>Dependent Variable</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Financial Stress</b>					
<i>US financial stress</i>	0.044*** (0.002)	0.053*** (0.000)	0.076*** (0.000)	0.074*** (0.000)	0.089*** (0.000)
<i>US financial stress x Trade link</i>	0.037*** (0.000)				-0.076** (0.084)
<i>US financial stress x Bank link</i>		0.016*** (0.000)			0.041*** (0.002)
<i>US financial stress x Portfolio link</i>			-0.012 (0.878)		0.045 (0.704)
<i>US financial stress x Direct investment link</i>				0.072* (0.075)	0.033 (0.742)
<i>Regional financial contagion</i>	1.400*** (0.000)	1.404*** (0.000)	1.401*** (0.000)	1.401*** (0.000)	1.409*** (0.000)
<i>Constant</i>	-0.070*** (0.000)	-0.070*** (0.000)	-0.071*** (0.000)	-0.071*** (0.000)	-0.070*** (0.000)
<b>Adjusted R<sup>2</sup></b>	0.270	0.272	0.268	0.269	0.267

Notes: Figures in italics are *p*-values. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% significance levels.

## 4.6 Endogeneity and Instrumental Variables Estimation

### 4.6.1 Panel Granger Testing to Investigate the Direction of Causality

Conceptually, many of the macroeconomic relations in the panel estimations are endogenous with causality running in both directions or affected by a third variable. For instance, the causality between GDP and financial stress can run in both directions. Slower growth weakens banks' balance sheets through higher non-performing loans, which in turn leads to higher financial stress. Weaker GDP can also affect financial stress through expectations, as dismal growth prospects are "priced-in" by investors, which is reflected through lower asset prices and, hence, higher financial stress. Meanwhile, the causality from financial shocks to economic activity occurs through many channels as well, for example, through bank capital, a financial accelerator mechanism and



uncertainty<sup>38</sup>. The relationship between credit and financial cycles may also be endogenous. Firstly, both variables are influenced in part by economic activity. Secondly, there are also self-reinforcing mechanisms - inflated asset prices and wealth are used as collateral to obtain credit, which further fuels asset prices, and so on<sup>39</sup>. Hence, as asset prices fall when financial stress increases, access to credit declines, which in turn depresses asset prices and causes financial stress to increase further.

Meanwhile, sustainability concerns about policy space, as reflected by international reserves, to finance the economy's foreign currency obligations may trigger a crisis or exacerbate one that is already under way. Similarly, a financial crisis that sparks a loss of confidence in the credit worthiness of the government's fiscal position can substantially increase the cost of further borrowings, which further worsens the government's fiscal position and, in turn, exacerbates the financial crisis that is already under way. The euro debt crisis is a recent example of two-way causality between the fiscal balance and financial stress.

The results from Table 4.3 are biased if such endogenous relationships are present. To investigate the direction of causality, pairwise panel granger causality tests between financial stress and the domestic variables are conducted. Two methodologies are used. The first test stacks the dataset, but with data from each cross-section not allowed to enter as a lagged variable in another cross-section. Hence, this test assumes that all cross-sections have common coefficients. The second test is based on Dumitrescu and Hurlin (2012) (D-H), which allows the coefficients to vary across cross-sections. Table 4.6

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<sup>38</sup> See Chapter 5 and Tng and Kwek (2015) for a more detailed discussion and references of the transmission channels.

<sup>39</sup> See Gerdesmeier, Reimers, and Roffia (2010) and Bayoumi and Darius (2011) for recent investigations of the inter-linkages between credit and asset prices.

presents the results. In the stacked based test, there is evidence of two-way causality only between financial stress (FSI) and bank credit. However, the D-H test shows some evidence for the presence of two-way causality for all domestic variables except international reserves.

**Table 4.6: Panel Pairwise Granger Causality Tests**

	Stacked	Dumitrescu-Hurlin
<b><u>FSI causes:</u></b>		
<i>Domestic bank credit</i>	0.000***	0.000***
<i>Current account</i>	0.001***	0.000***
<i>Real GDP</i>	0.000***	0.000***
<i>International reserves</i>	0.000***	0.000***
<i>Fiscal balance</i>	0.001***	0.000***
<b><u>FSI is caused by:</u></b>		
<i>Domestic bank credit</i>	0.008***	0.003***
<i>Current account</i>	0.417	0.062*
<i>Real GDP</i>	0.110	0.000***
<i>International reserves</i>	0.647	0.768
<i>Fiscal balance</i>	0.192	0.000***

Note: Figures in the table are p values. 4 lags are used in the estimations. In the stacked granger causality tests of two variables, A and B, the null hypothesis is A does not granger cause B, the alternative is A granger causes B. For the D-H test, the null is A does not homogeneously cause B, while the alternative is that some cross-section units exhibit evidence of granger causality.

#### 4.6.2 Addressing Endogeneity with Instrumental Variable Estimation

To address such endogeneity concerns, Balakrishnan *et al.* (2011) and Park and Mercado Jr (2014) lag their country-specific variables by one year in their annual panel model. In contrast, this analysis adopts an instrumental variables (IV) approach by using the previous four quarters (one year) as instruments for the country-specific variables and re-estimating the specifications in Table 4.3. Only the country-specific variables are instrumented as the ASEAN-5 economies are taken to be small-open economies and hence cannot influence external conditions. For the variables that are subjected to instrumentation, validity is satisfied because the variables are correlated with their lag terms and are exogenous to financial stress. Using lags as instruments also reflects

information delays as investors use past information to form expectations of current and future conditions to arrive at current investment decisions. Table 4.7 presents results from the IV estimations.

**Table 4.7: Instrumental Variable Estimation of the Panel Model**

<b>Dependent Variable</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Financial Stress</b>					
<i>World GDP</i>	2.653 (0.165)		8.171* (0.093)	5.266 (0.162)	8.215* (0.084)
<i>Commodity prices</i>	-0.246* (0.064)		-0.370 (0.114)	-0.627*** (0.009)	-0.265 (0.320)
<i>US financial stress</i>	0.077*** (0.000)		0.085*** (0.000)	0.094*** (0.000)	0.080*** (0.000)
<i>Regional financial contagion</i>	1.409*** (0.000)		1.034*** (0.000)	1.057*** (0.000)	1.023*** (0.000)
<i>GDP</i>		-4.530* (0.074)	-3.490 (0.452)		-4.963 (0.298)
<i>Bank Credit</i>		1.310* (0.093)	1.450* (0.100)		1.174** (0.049)
<i>International reserves</i>		0.000 (0.521)		0.000 (0.743)	0.000 (0.837)
<i>Current account</i>		0.002 (0.859)		-0.001 (0.864)	0.001 (0.909)
<i>Fiscal balance</i>		0.009 (0.423)		0.012 (0.343)	0.009 (0.426)
<i>Constant</i>	-0.070*** (0.000)	-0.068 (0.543)	-0.121*** (0.000)	-0.065 (0.567)	-0.110 (0.211)
<b>Adjusted R<sup>2</sup></b>	0.268	0.132	0.322	0.207	0.327

Notes: Figures in italics are p-values. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% significance levels.

Specification 1 in Table 4.7 is similar as the equivalent specification in Table 4.3 because only the domestic variables are subject to instrumentation. The IV estimation results for specifications 2-5 are broadly similar to the equivalent baseline estimations (Table 4.3). Higher levels of US Financial stress, regional financial contagion and domestic bank credit are associated with higher financial stress. The only notable difference is the increased (negative) sizes of GDP's coefficient in specifications 2, 3 and 5, and its level

of significance in specification 2 from non-significance to significance at the 10% level. There is thus tentative evidence that financial stress tends to occur after the peak of the business cycle, when growth is slowing, which exacerbates financial stress.

#### **4.7 The Sources of Financial Stress across Asset Markets**

The analysis thus far has sought to give insight to the determinants of financial stress. By using the overall FSIs as the dependent variable in the panel models, an implicit assumption has been a commonality in the sources of financial stress across asset markets and the banking system.

This section now analyses stress transmission across individual asset markets and the banking system. Two issues are addressed: First, is whether individual asset markets react similarly to common global and regional shocks. Different reactions across asset markets to common shocks can occur if domestic asset markets have asymmetric access to international financial markets. For example, Reinhart and Reinhart (1999) show theoretically that international capital market interest rates will not co-move with domestic interest rates when investors possess more access to international markets compared to domestic bank depositors. Regulatory restrictions that restrict or impose costs on foreign participation differently across asset markets can also cause a divergence in the effects of common external shocks among the individual asset markets (Kaminsky and Reinhart, 2002). The second issue is to analyse how financial stress spills over across asset markets. Studies of financial crises document that crises often involve multiple markets<sup>40</sup>, but have yet to document how the financial stress spills over across asset

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<sup>40</sup> For example, Laeven and Valencia (2008) document financial crises incidences from 1970-2007. They find that about 21% of the 124 identified banking crises that occurred during this period involved another market. Kaminsky and Reinhart (1999) find that currency crisis tend to have a higher probability of occurring when there is a banking crisis already underway.

markets while controlling for global, regional and country-specific macro-financial variables.

To analyse these issues, the baseline panel models are augmented in two aspects. First, the market specific FSIs replace the overall FSIs as the dependent variable. Second, the other market specific FSIs are included as independent variables. Consider the below panel model in equation (4):

$$FSI\_Market_{it}^j = \alpha_i + \sum_{g=1}^3 \beta^g EF_t^g + \gamma Cont_t + \sum_{l=1}^4 \mu^l Dom_{it}^l + \sum_{v=1}^3 \omega^v FSI\_Market_{it}^v + \varepsilon_{it}$$

(Equation 4.4)

All variables are as previously defined. The only new variable, *FSI\_Market*, denotes market specific financial stress in the banking system, equity market, foreign exchange market and bond market. The summation,  $\sum_{v=1}^3 \omega^v FSI\_Market_{it}^v$ , in equation 4.4 holds true for all  $v \neq j$ . Similar to the previous section, an instrumental variable approach is used to avoid endogeneity issues, using the previous 4 quarters as instruments for the country-specific variables. The results are presented in Table 4.8.

The results show that there are nuanced differences in the sources of financial stress across asset markets and compared with overall financial stress. US financial stress affects domestic overall financial stress with a positive coefficient (Table 4.8, specification 1). However, this positive relationship only applies to equity-related (Table 4.8, specification 3) and foreign exchange-related (Table 4.8, specification 4) financial stress<sup>41</sup>, with the coefficient for the former being much larger compared to the latter. Indeed, the larger

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<sup>41</sup> This positive relationship is consistent with Beirne and Gieck's (2012) finding that the degree of interdependence to global markets is the highest for the equity market.

coefficient for equity stress is consistent with Beirne and Gieck's (2012) recent finding that interdependence with global markets is more prevalent for equities and limited for the exchange rate.

**Table 4.8: Instrumental Variable Estimation of Market Specific Financial Stress**

<b>Dependent Variable</b>	<b>1.</b>	<b>2.</b>	<b>3.</b>	<b>4.</b>	<b>5.</b>
<b>Financial Stress</b>	<b>Overall</b>	<b>Bank</b>	<b>Equities</b>	<b>Foreign Exchange</b>	<b>Domestic Bond</b>
<i>World GDP</i>	8.215* (0.084)	2.190 (0.769)	10.824 (0.221)	-13.70*** (0.000)	8.786 (0.166)
<i>Commodity prices</i>	-0.265 (0.320)	0.248 (0.585)	-0.561 (0.139)	0.588 (0.088)	-0.337 (0.237)
<i>US financial stress</i>	0.080*** (0.000)	-0.135*** (0.001)	0.256*** (0.000)	0.081*** (0.012)	-0.158*** (0.000)
<i>Regional financial contagion</i>	1.023*** (0.000)	0.393** (0.012)	0.444*** (0.005)	0.935*** (0.000)	-0.286 (0.223)
<i>GDP</i>	-4.963 (0.298)	2.067 (0.530)	-13.398*** (0.004)	8.635*** (0.092)	-0.799 (0.825)
<i>Bank Credit</i>	1.174** (0.049)	-0.101 (0.954)	-0.632 (0.488)	0.008 (0.994)	4.087*** (0.000)
<i>International reserves</i>	0.000 (0.837)	0.002* (0.062)	0.000 (0.465)	0.000 (0.687)	-0.002 (0.168)
<i>Current account</i>	0.001 (0.909)	0.016 (0.157)	-0.005 (0.226)	-0.011* (0.053)	-0.001 (0.923)
<i>Fiscal balance</i>	0.009 (0.426)	-0.028 (0.220)	0.007** (0.046)	0.017 (0.235)	0.024 (0.098)
<i>Financial Stress (Bank)</i>			0.147* (0.071)	0.134** (0.047)	0.317** (0.030)
<i>Financial Stress (Equities)</i>		0.157* (0.088)		0.094*** (0.001)	0.775*** (0.000)
<i>Financial Stress (Foreign Exchange)</i>		0.288 (0.167)	0.169 (0.104)		-0.305* (0.013)
<i>Financial Stress (Domestic Bonds)</i>		0.181* (0.079)	0.418*** (0.000)	-0.041 (0.574)	
<i>Constant</i>	-0.070*** (0.00)	-0.255*** (0.009)	0.012 (0.876)	0.025 (0.682)	0.188 (0.263)
<b>Adjusted R<sup>2</sup></b>	<b>0.27</b>	<b>0.200</b>	<b>0.663</b>	<b>0.071</b>	<b>0.585</b>

Notes: Figures in italics are p-values. \*, \*\* and \*\*\* denote statistical significance at the 10%, 5% and 1% significance levels.

The corresponding coefficients for the effects of US financial stress is negative for bank-related (Table 4.8, specification 2) and bond-related (Table 4.8, specification 5) financial stress. Therefore, the findings show that external financial turbulence spills over to ASEAN-5 financial markets through the equity and foreign exchange markets. Interestingly, the negative coefficients for the banking system and domestic bond market indicate that these markets act to partially absorb and mitigate the impact of the external financial shock<sup>42</sup>.

A possible interpretation of this result is that when external financial shocks occur, there is a wave of capital outflows that causes a decline in the values and volatility spikes in equities and the exchange rate. The lower value and volatile equity prices reduce the conduciveness to raise financing from equity markets. This induces agents to turn to the domestic banking system and domestic bond market, where financing supply is more assessable in comparison.

Regional financial contagion is most prevalent in the foreign exchange market, followed by the equity market and the least for domestic banks, as reflected respectively by the highest to lowest sizes of the statistically significant coefficients. Regional contagion is not a significant determinant of bond market stress.

The results also indicate that financial shocks are often pervasive. Sector or asset-specific shocks often transmit to other markets. Financial stress from the banking sector and equity market are the most pervasive as they are associated with higher financial stress among each other and in all other asset markets. This result is consistent with Kaminsky and

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<sup>42</sup> Similarly, Beirne and Gieck (2012) find that adverse US equity shocks causes a lowering of domestic bond yields in Asian economies and that within market shocks are transmitted with negative association. They also interpret their results as evidence that agents turn to domestic bond markets when US financial conditions deteriorate.

Reinhart's (1999) finding that the probability of a currency crisis occurring is higher when conditioned on the presence of a banking crisis. In addition, vicious cycles are an important aspect in the transmission of financial stress. Problems in the banking system make economies more vulnerable to currency depreciations or devaluations through sudden stops in cross-border capital flows from domestic debt and equity markets. Meanwhile, equity market stress reduces fee-based income from banks and can also cause loan portfolios to deteriorate as the negative wealth effects from lower equity prices lowers the ability of economic agents to service their debt obligations.

#### **4.8 Conclusion**

This analysis attempts to contribute to the understanding of the transmission of financial stress in the ASEAN-5 economies using a panel data estimation methodology. Three variables are found to be significant determinants and robust to model specifications and methodology: US financial stress, regional financial contagion and domestic bank credit. The findings are consistent with the narrative from the financial crisis and financial contagion literatures: Loose credit conditions are precursors of financial crises, financial markets in emerging and small-open economies are highly susceptible to spillovers from external conditions and financial episodes marked by large contagion effects are, in general, more severe. There is evidence that trade and financial linkages play important roles in the transmission of financial stress across borders. While pinning down and differentiating the individual channels was empirically challenging, cross-border bank linkages seemed to be the most important over the sample studied.

The findings also point to extensive linkages of banks and equity markets with all other asset markets. High stress in either is significantly associated with higher financial stress elsewhere. In particular, there is a vicious cycle of stress transmission between the banking system and equity markets, where adverse conditions in either exacerbates stress levels in the other, which in turn worsens the originating source of stress, and so on.



## CHAPTER 5 : THE IMPACT OF FINANCIAL STRESS ON ECONOMIC ACTIVITY AND MONETARY POLICY TRANSMISSION IN ASEAN-5 ECONOMIES<sup>43</sup>

### 5.1 Introduction

There has long been recognition that macroeconomic and financial stability are interlinked. This is indeed the reason both mandates often lay within the same institution, the central bank, as policy efforts to achieve either mandate is complementary towards achieving the other. Before the Global Financial Crisis (GFC) of 2007-2009, there was often a dichotomy in the approaches and analysis to achieve these goals. Monetary policy was tasked to achieve macroeconomic stability. This analysis usually centred around Dynamic Stochastic General Equilibrium (DSGE) and macro-econometric models that embed a “Taylor rule”, in which a short-term interest rate that is controlled by the central bank is modelled to react to the inflation gap and output gap<sup>44</sup>. Frictions that arise in financial markets especially during crises periods were largely absent in these models. Thus the effects of financial crises were often underestimated (Mishkin, 2009) or discounted as outliers in these models. Meanwhile, the supervisory and regulatory departments would assess the risks of financial market misconduct, often at the

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<sup>43</sup> The main findings in this chapter have been published in Tng and Kwek (2015). Earlier drafts were presented at the 2014 Joint Meetings of the Australian Conference of Economists and Econometric Society Australasian Meetings (ESAM) in Tasmania, Australia, the 2014 ISI Regional Statistics Conference in Kuala Lumpur, Malaysia, and the Bank of Thailand and Bank for International Settlements (BoT-BIS) 8<sup>th</sup> Annual Workshop of the Asian Research Networks 2015. This chapter benefited from the valuable feedback received at these conferences.

<sup>44</sup> The inflation gap is the difference between current and desired/target inflation, while the output gap is the difference between current and potential output. This is original and most often applied version as suggested by Taylor (1993). Subsequent studies have analysed monetary policy using augmented versions of the Taylor rule with other variables, such as asset prices and credit as done in Borio and Lowe (2004) and within a calibrated model with the exchange rate as in Svensson (2000).

institutional level and in isolation with monetary policy considerations or the consequences. This was the general approach before the GFC<sup>45</sup>.

The GFC episode was a forceful reminder of the significant linkages between the financial cycle and macroeconomic cycle, and how disruptive episodes of financial instability are to the real economy. Although conventional empirical macroeconomic models were unable to forecast the true effects of the crisis, a separate literature that documents historical experiences in the aftermath of financial crisis finds that downturns from crises are often deeper with recoveries that take longer (Reinhart & Rogoff, 2008b, 2014). When viewed through the lens of history, the scale and depth of the economic downturn during the GFC was therefore consistent with past financial crisis experiences. The inadequacy of empirical macro models to match these stylised facts is cause for concern because they are often used for forecasting and policy analysis. In addition to the problem of experiencing larger forecast errors during crisis periods, this shortcoming also highlights important but unanswered questions pertaining to the interactions between financial stress and monetary policy, such as whether monetary policy is influenced directly by financial stress and if monetary policy is effective during crisis periods.

Against this backdrop, this chapter aims to address these issues for five small-open economies - Indonesia, Malaysia, the Philippines, Singapore and Thailand (henceforth, ASEAN-5). While these economies were not at the epicentre of the crisis, the aforementioned issues remain. In addition, as small and open economies, the GFC served as a stark reminder that their growth and financial stability prospects are highly

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<sup>45</sup> Some central banks also utilise macro-prudential policy to manage macro-level financial stability risks. However, these practices were more the exception rather than the rule before the GFC and became more widely accepted and applied after the GFC.

susceptible to both domestic imbalances and external spillovers. ASEAN-5 growth was significantly affected through a combination of weak exports and financial spillovers.

A Structural Vector Autoregression (SVAR) approach is used to give insight to four questions: First, what is the impact of financial stress on real economic activity? While the spillover to growth from lower exports is well understood, relatively less is known of the growth effects from the financial spillovers. This is especially true for economies with few past incidences of financial crisis, such as the ASEAN-5, to infer the growth effects from. Second, does monetary policy respond systematically to increases in financial stress? This question arises from a notable observation that although the global policy responses during the GFC period were tailored largely to country-specific conditions, central banks globally reduced their policy interest rates (IRs) during this period. This held true irrespective of the respective central banks' monetary policy mandates (inflation targeting or not). Third, is monetary policy effective in alleviating financial stress? Finally, do changes in the level of financial stress alter the transmission of monetary policy to the real economy? These last two questions allude to the current ongoing debate on whether monetary policy was effective in aiding the economic recovery during the GFC (Mishkin, 2009).

The model builds from the existing open-economy Vector Autoregression (VAR) literature by integrating the Financial Stress Indices (FSIs) from Chapter 3 into the VAR model to capture the financial stability aspect of financial cycles in global financial markets and in the ASEAN-5 economies. Through the FSIs, the VAR models capture in a parsimonious manner distinct features of financial episodes, such as changes in the underlying risk appetite, information asymmetries and uncertainty. Using the FSIs has the advantage of facilitating analysis of macro-financial linkages during tranquil and stressful periods in financial markets, as they are continuous measures of financial stress.

The FSIs are thus useful for analysing issues pertaining to the financial cycle in countries with few historical incidences of severe financial episodes.

The findings show that an increase in financial stress leads to tighter credit conditions and lower economic activity in all five sample countries. The estimated impact on the real economy displays an initial rapid decline followed by a gradual dissipation. In Malaysia, the Philippines and Thailand, the central banks reduce policy interest rates when financial stress increases, although there is substantial cross-country variation in the magnitude and time dynamics. The lower policy interest rates are found to have little significant effects in lowering financial stress, but are still effective in stimulating economic activity through other channels. Overall, this result is consistent with these central banks acting to achieve macroeconomic stability, as lower policy interest rates act to offset the contractionary effects of higher financial stress on economic activity.

The remaining chapter is organised as follows. Section 5.2 details the methodology of the paper, including the data used, specification issues and the specification of the SVAR model. Section 5.3 presents the results. Section 5.4 presents results from robustness tests. The last section concludes.

## **5.2 Methodology**

A Structural VAR (SVAR) approach is used to assess the impact of financial stress on the economy and the linkages between financial stress and monetary policy. This modelling approach draws primarily from the recent efforts to study the linkages between financial conditions and economic activity by integrating FSIs into VAR-based models. Representative studies are Li and St-Amant (2010), Davig and Hakkio (2010), Hollo *et al.* (2012), Mallick and Sousa (2013), Roye (2011), Afonso *et al.* (2011), Galvao and Owyang (2014) and Kremer (2015). Although the specific FSIs that are used for analysis vary across studies, all reflect stress in financial markets through a combination of

declining and volatile asset prices and higher bond yields/spreads. The existing analyses have thus far tended to focus on developed economies, particularly Euro Area economies and the United States (US), which is unsurprising given the recent financial episodes there. This study instead focuses on the ASEAN-5 economies. From a methodological perspective, the current analysis contributes to this emerging literature by adapting the model to be more suited for small-open economies through the model's structural assumptions and inclusion of additional external variables to account for the large exposures to the foreign environment.

### 5.2.1 Data

The sample consists of Indonesia, Malaysia, the Philippines, Singapore and Thailand (ASEAN-5). The variables are in monthly frequency and range from January 1997 to December 2013. A summary of the variables is presented in Table 5.1. Appendix C contains plots of the variables, details on data transformations and additional information on the variables, including the monetary policy and exchange rate regimes, how the monetary policy variable was constructed in cases where there was a regime change and other country-specific idiosyncrasies.

Three variables characterise the external environment: A global commodity price index ( $GCP$ ), a world industrial production index ( $IPI_w$ ) and a financial stress index for the US economy ( $FSI_{us}$ ).  $GCP$  captures global prices of food, fuel and metal commodities.  $IPI_w$  captures global real economic conditions. This global measure is preferred to the more commonly used US focused indicator, as it abstracts from trade diversification away from the US. In addition, focusing on US demand alone risks mis-identification of commodity price shocks, as commodity price movements are increasingly attributable to demand from emerging markets, such as China.

The final external variable is an index of financial stress for the US economy,  $FSI_{us}$ , which proxies for global financial conditions. To be sure, financial episodes occur in other countries as well, especially in emerging markets. However, Kaminsky & Reinhart (2003) find that financial episodes tend to remain confined within their regions unless they spread to major financial centres. This suggests that ASEAN-5 financial markets will remain unaffected by financial episodes that originate outside the region and major financial centres (such as the US financial market), and that financial spillovers to the region only occur when major financial markets are affected. Therefore, this analysis does not attempt to measure global financial stress and assumes that US financial stress aptly reflects global financial conditions.

**Table 5.1: Summary of Variables used in the Estimations**

Variable	Abbreviation	Definition	Source
<b>External</b>			
<i>Commodity prices</i>	$GCP$	Commodity price index	International Monetary Fund
<i>World output</i>	$IPI_W$	World industrial production index	CPB Netherlands Bureau for Economic Policy Analysis
<i>US Financial stress</i>	$FSI_{US}$	US Financial stress index	Hakkio and Keeton (2009)
<b>Domestic</b>			
<i>Output</i>	$IPI$	Industrial production index	International Financial Statistics (IFS)
<i>Prices</i>	$CPI$	Consumer price index	IFS
<i>Interest rate</i>	$IR$	Short-term interest rate	IFS
<i>Credit</i>	$C$	Bank credit, deflated by CPI	IFS
<i>Exchange rate</i>	$EX$	Nominal effective exchange rate	Bank for International Settlements
<i>Financial stress</i>	$FSI$	Financial stress index	Tng <i>et al.</i> (2012)

Six variables characterise the domestic economy: the industrial production index ( $IPI$ ) captures real economic activity; the consumer price index ( $CPI$ ) reflects the price level; the short-term interest rate ( $IR$ ) is the monetary policy instrument in Indonesia, Malaysia,

the Philippines and Thailand, and a floating short-term money market interest rate for Singapore; Credit ( $C$ ) is total claims from the domestic banking system, and; the exchange rate ( $EX$ ) is the nominal effective exchange rate. The last variable, an index of financial stress ( $FSI$ ), is a summary indicator of stress in financial markets from Chapter 3.

### 5.2.2 Unit Root Testing

The time-series properties of the variables affect how the VAR model is specified. Specifically, the trend component in a series may be deterministic or stochastic, and the appropriate action to control for the trend component depends on its nature. For instance, a series with a deterministic trend should be de-trended by regressing it on a polynomial trend of appropriate degree and obtaining the residuals. In contrast, a series with a unit root of order  $d$  should be transformed to a stationary process through differencing by a similar order. Hence, unit root tests are conducted to ascertain the variables' order of integration, using the test developed in Phillips and Perron (1988) (PP). All variables are subject to two specifications in the unit root tests, first with a drift (constant) and second with a drift and a linear time trend. The regression for the test can be expressed as:

$$\Delta y_t = \beta_0 + \delta y_{t-1} + \beta_1 t + \varepsilon_t \quad (\text{Equation 5.1})$$

The null hypothesis,  $H_0: \delta=0$ , indicates that the  $y_t$  sequence contains a unit root. An issue that arises when conducting the unit root tests is whether there are structural breaks over the sample period. If structural change occurred which changed the mean, trend or both in a stationary data generation process, not controlling for these changes in the unit root tests will bias the results in favour of a unit root (non-stationary). To the extent that there are structural breaks in the series over the period studied for the ASEAN-5 economies, they are most likely to have occurred during or close to the AFC period. In Malaysia, the banking system underwent significant consolidation shortly after the Asian Financial Crisis. Capital control measures were introduced and the Malaysian ringgit was pegged

to the US Dollar in September 1998. In Thailand, there were likely changes in credit intermediation between 1997 and 1999, brought forth by the closure of over forty finance companies. In Indonesia, financially insolvent banks were closed during the AFC period. There were also several unique events in 1998 and 1999, such as the removal of large food subsidies, significant social unrest, political uncertainty resulting from a leadership change and delayed disbursements of IMF aid on several occasions that likely affected the macroeconomic performance of the country. As shown in Appendix C, many of the sample countries also experienced changes in monetary policy regimes between 1997 and 2013. These events and structural changes should be but are difficult to explicitly account for in the unit root tests and SVAR estimations.

The unit root tests are conducted over the entire sample period, 1997-2013, and from 2000 onwards, since many of the potential candidates of structural breaks occurred between 1997 (when the sample starts) and 2000. A similar test result from the two sample periods will give more confidence on the underlying data generation process of the variables. A different finding across sample periods indicates that structural change may have occurred during the earlier period and hence biased the test statistics.

The unit root tests are conducted on the variables in levels, with and without a constant, and in first difference to investigate the stationary properties after differencing the variables and controlling for the presence of a deterministic trend. Table 5.2 presents the unit root test results.

The results between the full sample (1997-2013) and sub-sample (2000-2013) are mostly similar, but differ in some cases. The test statistics from the level regressions tended to be statistically significant with lower  $p$ -values in the full sample. In particular, this is the case for US financial stress (with constant); the exchange rate for Indonesia, Malaysia



and Thailand in the test regressions with a constant and with both the constant and linear time trend, and Singapore's short term interest rate in the level specifications.

**Table 5.2: Summary of Phillip-Perron Unit Root Test Statistics**

	Full Sample (1997-2013)			Sub-sample (2000-2013)		
	Level (C)	Level (C,T)	1st Difference	Level (C)	Levels (C,T)	1st Difference
<b>External</b>						
<i>Commodity price</i>	-0.611	-3.167*	-10.718***	-1.047	-2.606	-9.722***
<i>World output</i>	-0.912	-2.657	-10.195***	-0.758	-2.317	-9.003***
<i>US financial stress</i>	-2.685*	-2.649	-12.429***	-2.361	-2.373	-11.269***
<b>Indonesia</b>						
<i>Output</i>	0.146	-3.513***	-19.284***	-0.201	-5.251***	-21.993***
<i>Prices</i>	-2.841*	-2.723	-6.438***	-2.070	-1.078	-11.199***
<i>Interest rate</i>	-2.488	-3.159*	-7.510***	-1.523	-2.251	-6.315***
<i>Real credit</i>	-0.429	-1.818	-14.792***	1.254	-0.403	-11.111***
<i>Exchange rate</i>	-3.508***	-3.567**	-10.540***	-1.123	-2.783	-10.215***
<i>Financial stress</i>	-5.523***	-7.004***	-30.238***	-4.052***	-5.091***	-29.065***
<b>Malaysia</b>						
<i>Output</i>	-1.253	-2.724	-21.177***	-1.585	-2.625	-20.357***
<i>Prices</i>	-0.509	-2.494	-11.004***	0.441	-2.820	-9.939***
<i>Interest rate</i>	-2.200	-1.885	-12.922***	-2.235	-2.194	-13.024***
<i>Real credit</i>	1.252	-0.562	-13.135***	2.386	-0.729	-11.779***
<i>Exchange rate</i>	-4.051***	-3.726**	-13.393***	-2.093	-2.083	-11.017***
<i>Financial stress</i>	-2.629*	-3.606**	-16.290***	-3.128**	-3.564***	-13.608***
<b>The Philippines</b>						
<i>Output</i>	-2.766*	-2.729	-20.532***	-1.417	-1.360	-17.138***
<i>Prices</i>	-1.564	-2.090	-8.489***	-0.937	-1.697	-6.354***
<i>Interest rate</i>	-1.665	-4.814***	-20.001***	-1.456	-3.035	-8.293***
<i>Real credit</i>	0.598	-0.455	-13.158***	1.435	-0.104	-12.860***
<i>Exchange rate</i>	-3.686***	-2.485	-10.892***	-2.979	-2.668	-9.726***
<i>Financial stress</i>	-3.686***	-5.007***	-19.039***	-4.233***	-4.952***	-19.656***
<b>Singapore</b>						
<i>Output</i>	-1.033	-6.353***	-26.928***	-1.301	-5.700***	-24.590***
<i>Prices</i>	2.280	-0.748	-11.984***	1.749	-1.215	-10.603***
<i>Interest rate</i>	-3.485***	-4.987***	-22.717***	-1.952	-2.614	-16.888***
<i>Real credit</i>	0.506	-0.951	-13.392***	1.797	-0.699	-11.295***
<i>Exchange rate</i>	0.825	-1.127	-11.638***	1.111	-1.314	-10.658***
<i>Financial stress</i>	-12.042***	-12.225***	-89.099***	-10.854***	-11.075***	-43.704***
<b>Thailand</b>						
<i>Output</i>	-1.143	-2.864	-15.636***	-1.604	-2.565	-14.579***
<i>Prices</i>	-0.709	-2.431	-11.100***	0.377	-2.752	-10.470***
<i>Interest rate</i>	-2.382	-2.444	-17.335***	-1.984	-1.909	-9.240***
<i>Real credit</i>	1.008	-0.596	-14.193***	1.861	-1.953	-13.485***
<i>Exchange rate</i>	-4.004***	-4.224***	-10.746***	-1.345	-2.990	-9.545***
<i>Financial stress</i>	-4.417***	-5.154***	-31.528***	-3.536***	-3.625**	-16.862***

Notes: "C" refers to the constant, "T" refers to the trend. Values are the adjusted *t*-statistics. \*, \*\* and \*\*\* denote significance at 10%, 5% and 1%. The tests are conducted in EViews 8.0 using the Newey-West bandwidth selection method and Bartlett kernel function to estimate the residual spectrum at frequency zero.

Focusing now only on the unit root test of the variables in levels with only a constant and with a constant and trend from the sub-sample (2000 onwards) to eschew from potential structural break issues during the AFC period, the test results are consistent in all cases with two exceptions<sup>46</sup> - Output in Indonesia and Singapore. In both cases, output in Indonesia and Singapore became trend stationary after including a time trend. Financial stress is consistently stationary in level terms in all sample economies, indicating strongly that this series is  $I(0)$ . For all the variables, the null hypothesis was rejected at the 1% significance level in first difference, indicating stationarity after this transformation.

### 5.2.3 Specification Issues

Two specification issues arise from analysing the data properties and unit root results. The first is how best to address the structural breaks that potentially occurred during the AFC period. Many VAR studies tackle this issue by conveniently splitting their sample into pre-AFC and post-AFC sub-samples<sup>47</sup>. In this analysis, the period before the AFC is relatively short since the sample here begins in 1997. This partially mitigates the need to control for pre-crisis conditions. In addition, a benefit from using the full sample period is that it includes the AFC episode, which for the ASEAN-5 economies is a major domestic financial episode to have occurred during this period. Having this variation in domestic financial stress during the AFC in the sample is useful to differentiate between domestic and foreign financial shocks, and hence their impact on the economies. In addition, while using a post-AFC sub-sample is a convenient way to avoid having to explicitly control for structural changes, a pitfall is that the smaller sample results in a lower efficiency in the econometric estimates.

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<sup>46</sup> Excluding the different levels of significance.

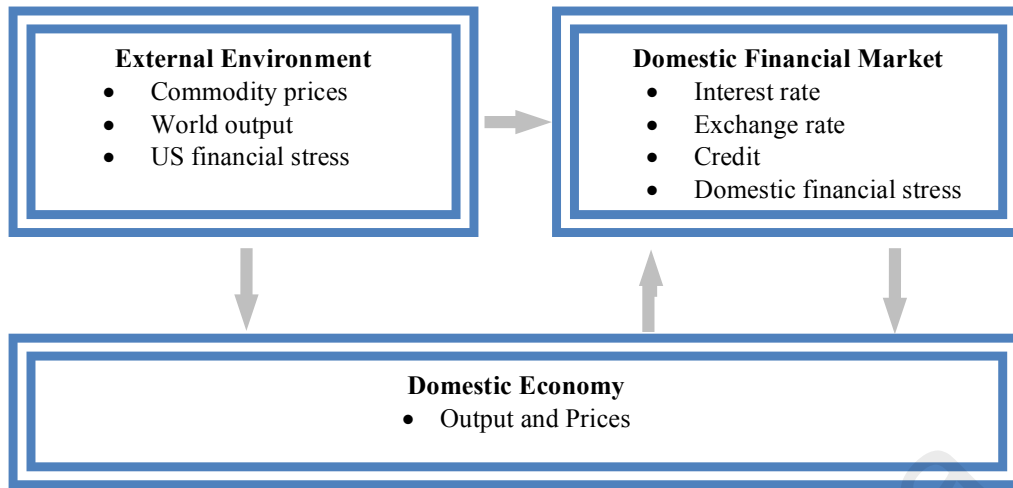
<sup>47</sup> See Fung (2002), Disyatat and Vongsinsirikul (2003), Hesse (2007) and Raghavan, Silvapulle, and Athanasopoulos (2012) for some references.

The second issue is how best to estimate a VAR model when there are both  $I(1)$  and  $I(0)$  variables, and whether to include a deterministic trend in cases where the trend is found to be deterministic instead of stochastic. The later issue is pertinent in cases where the trend component was found to be deterministic (output in Indonesia and Singapore). Many studies, following from Sims (1980), Sims, Stock, and Watson (1990) and Ramaswamy and Sloek (1997), estimate their VARs with the  $I(1)$  variables in levels under the premise that their interest is not in the parameter estimates but rather in the inter-relationships. Moreover, parameter estimates are usually not focused on in VARs since they are often over-parameterised. These studies instead analyse the time dynamics of interest from the impulse response functions. In addition, from an estimation and inferential perspective, in cases when there is a cointegrating relationship among the  $I(1)$  variables, estimating the VAR model in levels is appropriate because the VECM can be expressed as a VAR model in levels.

Therefore, the SVAR models in this study are estimated in levels, with the results focusing on the time dynamics from the impulse response functions. While acknowledging the potential pitfalls associated with estimating SVARs in levels, this is nonetheless a revealing way to examine the inter-relationships.

#### **5.2.4 The Structural Vector Autoregression (SVAR) Model**

A schematic that summarises the causality assumptions of the SVAR model is illustrated in Figure 5.1. Domestic output and prices are influenced by two groups of variables: The first is the external environment, consisting of commodity prices, world output and US financial stress. The second group characterises domestic financial markets with a short-term interest rate, the exchange rate, credit and domestic financial stress. The ASEAN-5 economies are modelled as small-open economies, and are thus assumed to be affected by but cannot affect external conditions.



**Figure 5.1: Causality Assumptions in the VAR Model**

The external variables can directly affect domestic output and prices through global trade, price and financial channels, and indirectly through domestic financial markets. For example, external conditions may influence monetary policy, which in turn affects domestic financial conditions, output and prices. External conditions also influence the exchange rate and domestic asset prices through cross-border capital flows. This consequently affects the terms of trade, wealth and financing conditions, which in turn affect domestic output and prices. The financial accelerator mechanism may also amplify the direct effects of external shocks through a feedback effect from interactions between the real economy and financial markets. For instance, when faced with an adverse external demand shock, lower profits and deteriorating balance sheet positions of export-oriented companies' may cause an increase in borrowing premiums and lower access to financing. This leads to moderating investment and credit-financed trade.

To characterise these channels, consider the following SVAR model for each sample economy:

$$AX_t = B(L)X_{t-1} + \varepsilon_t \quad (\text{Equation 5.2})$$

$X$  is a vector of variables of similar ordering as Table 5.1.  $A$  is a matrix of contemporaneous coefficients in structural form.  $B(L)$  is a matrix polynomial in the lag operator,  $L$ .  $\varepsilon_t$  is a vector of structural disturbances, such that:

$$\varepsilon_t = Ae_t \quad (\text{Equation 5.3})$$

$e_t$  is a vector of residuals from the corresponding reduced-form VAR. The equations can be organised into external and domestic blocks. Structural shocks are identified using the approach suggested by Sims (1986), Bernanke (1986) and applied by many others thereafter, by placing restrictions on the contemporaneous coefficients. The assumptions made on the matrix,  $A$ , are:

$$\begin{bmatrix} \varepsilon_{GCP} \\ \varepsilon_{IPIw} \\ \varepsilon_{FSIus} \\ \varepsilon_{IPI} \\ \varepsilon_{CPI} \\ \varepsilon_{IR} \\ \varepsilon_C \\ \varepsilon_{Ex} \\ \varepsilon_{FSI} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 & 0 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & 0 & 0 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} & 0 & 0 \\ a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & a_{87} & a_{88} & 0 \\ a_{91} & a_{92} & a_{93} & a_{94} & a_{95} & a_{96} & a_{97} & a_{98} & a_{99} \end{bmatrix} \begin{bmatrix} e_{GCP} \\ e_{IPIw} \\ e_{FSIus} \\ e_{IPI} \\ e_{CPI} \\ e_{IR} \\ e_C \\ e_{Ex} \\ e_{FSI} \end{bmatrix} \quad (\text{Equation 5.4})$$

Commodity prices are contemporaneously exogenous to all other variables. World production and US financial stress are identified recursively by assuming the former is contemporaneously affected by commodity prices, while US financial stress is contemporaneously affected by commodity prices and world production. The external variables are contemporaneously unaffected by the country-specific variables. The first four variables in the domestic block are ordered recursively in the following order -  $IPI$ ,  $CPI$ ,  $IR$ ,  $C$ ,  $EX$  and  $FSI$ . The short-term interest rate broadly follows a Taylor rule

principle, as it reacts contemporaneously to economic activity (IPI) and prices (CPI)<sup>48</sup>. The exchange rate is ordered before financial stress to model the narrative that a financial shock can trigger capital outflows and affect the exchange rate with a lag.

To more strictly impose the small-open economy assumption, block-exogeneity restrictions are imposed on the domestic variables in the external equations. This means that the external variables affect each other in lags, but are unaffected by the domestic variables contemporaneously and in lags. This approach follows from Cushman and Zha (1997), Maćkowiak (2007), Genberg (2005) and Raghavan *et al.* (2012). The block-exogeneity restrictions translate to the coefficient matrix for the lag structure,  $B_i$ , where  $i$  represent the lags, with the variables ordered similar to Table 5.1:

$$B = \begin{bmatrix} b_{11} & b_{12} & b_{13} & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{21} & b_{22} & b_{23} & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{45} & b_{46} & b_{47} & b_{48} & b_{49} \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} & b_{56} & b_{57} & b_{58} & b_{59} \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & b_{66} & b_{67} & b_{68} & b_{69} \\ b_{71} & b_{72} & b_{73} & b_{74} & b_{75} & b_{76} & b_{77} & b_{78} & b_{79} \\ b_{81} & b_{82} & b_{83} & b_{84} & b_{85} & b_{86} & b_{87} & b_{88} & b_{89} \\ b_{91} & b_{92} & b_{93} & b_{94} & b_{95} & b_{96} & b_{97} & b_{98} & b_{99} \end{bmatrix} \quad (\text{Equation 5.5})$$

The estimations are carried out using four lags. Table 5.3 presents results from the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC), with six lags set as the maximum length given the relatively short sample. The AIC chose a longer lag length with a wide range from three to six, while the SIC selected one lag for all countries.

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<sup>48</sup> This reaction function is not exactly the same as the one originally suggested in Taylor (1993) as other variables enter the function in lags.

Given these differing results, these test results are used as guides rather than a hard-and-fast rule. The analysis chooses the average of the AIC lags of 4.

**Table 5.3: Lag Length Selection from AIC and SIC Tests**

	Akaike Information Criterion	Schwarz Criterion
Indonesia	6	1
Malaysia	3	1
The Philippines	4	1
Singapore	3	1
Thailand	4	1

### 5.3 Results

This section presents the estimation results from the SVAR models. The impulse responses are plotted over 60 months with the 95<sup>th</sup> percentile confidence intervals<sup>49</sup>.

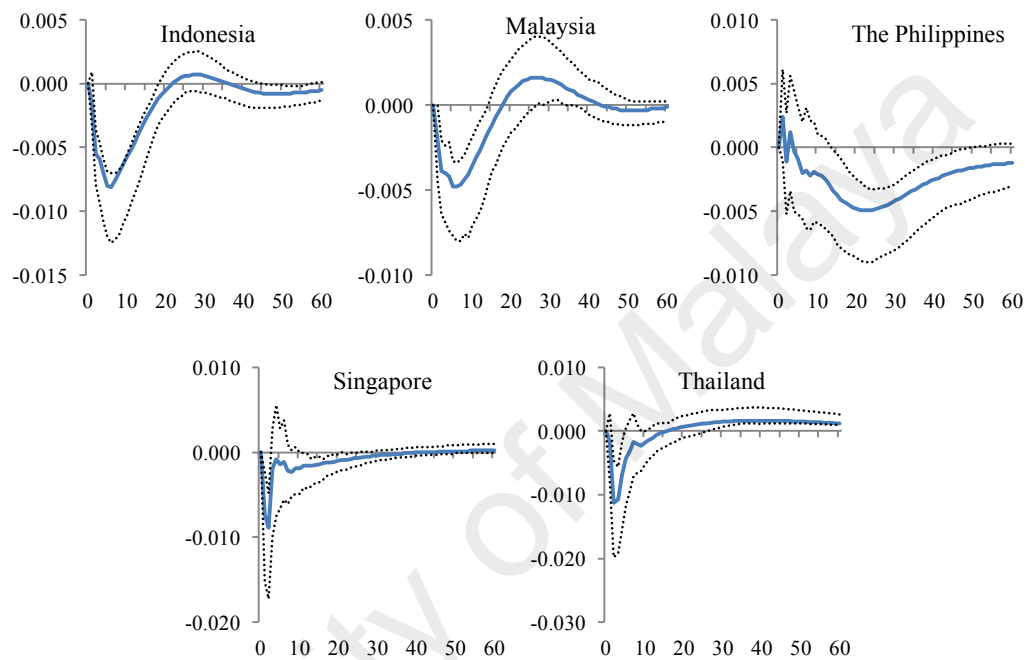
#### 5.3.1 The Impact of Financial Stress

Figure 5.2 illustrates the impulse responses of industrial production to a one standard deviation unexpected increase in financial stress. The impulse responses show that higher financial stress leads to a decline in output. A similarity in the output responses across countries is that the declines are initially rapid and followed by a more gradual dissipation. Most of the contractionary effects occur within the first year after the shock with a majority of the effects dissipating by the second year. There is nonetheless some cross-country heterogeneity in the time dynamics. In Indonesia and Malaysia, there is a subsequent overshoot in IPI, which is indicative of the presence of an uncertainty channel in which firms subsequently react to pent-up demand for capital and labour. The response for the Philippines is the most persistent, with the largest effects felt approximately two years after the shock, followed by dissipation over the subsequent three years. *IPI* in

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<sup>49</sup> The bootstrap methodology applied is from Hall (1992) using 100 replications. Increasing the number of replications to 500 does not materially change the results.

Singapore and Thailand recover quickly with their *IPIs* returning to baseline levels approximately one year after the shock. In general, the time dynamics - a sharp drop and gradual dissipation - are consistent with results from other similar studies, for instance Davig and Hakkio (2010) for the US economy and Hollo *et al.* (2012) for Euro Area economies.



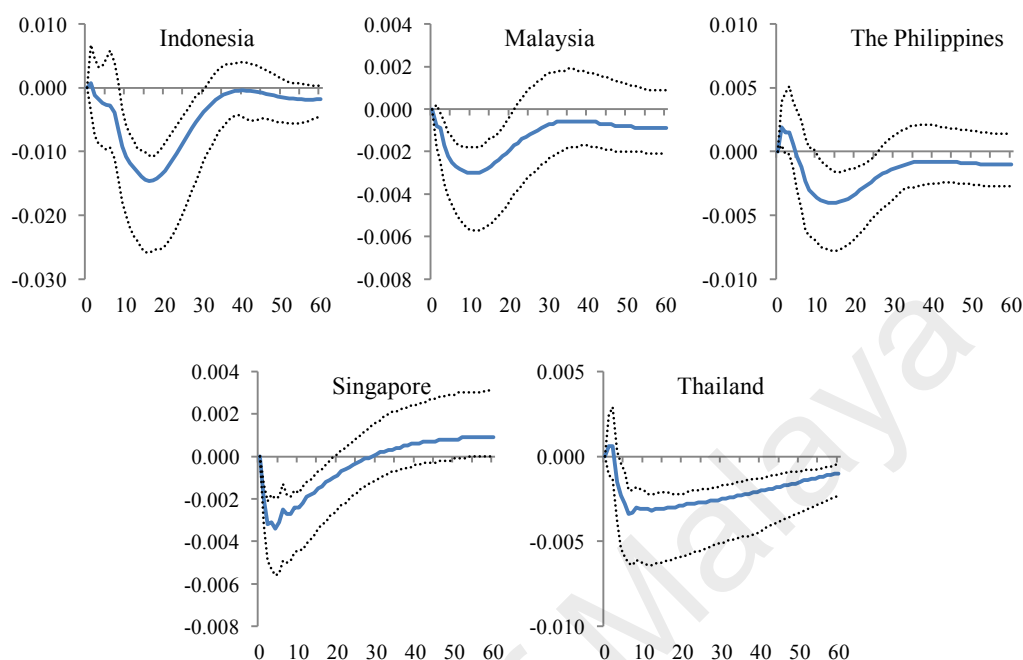
Source: Author's estimates

**Figure 5.2: Response of IPI to a Financial Stress Shock**

A main conduit in which financial stress causes a reduction in economic activity is through lower access to financing from banks. Figure 5.3 gives evidence of this channel by illustrating the impulse responses of real credit to a one standard deviation increase in financial stress. Real credit declines in all cases. Similar to the previous impulse responses, the initial declines in real credit are the sharpest during the first year after the shock, which is then followed by a more gradual dissipation. While deteriorating credit conditions contribute to moderating economic activity as financial stress increases, one factor that may limit the downward pressure on the real economy is if higher financial



stress causes higher cross-border capital outflows and depreciation in the exchange rate, which then stimulates the export sector.



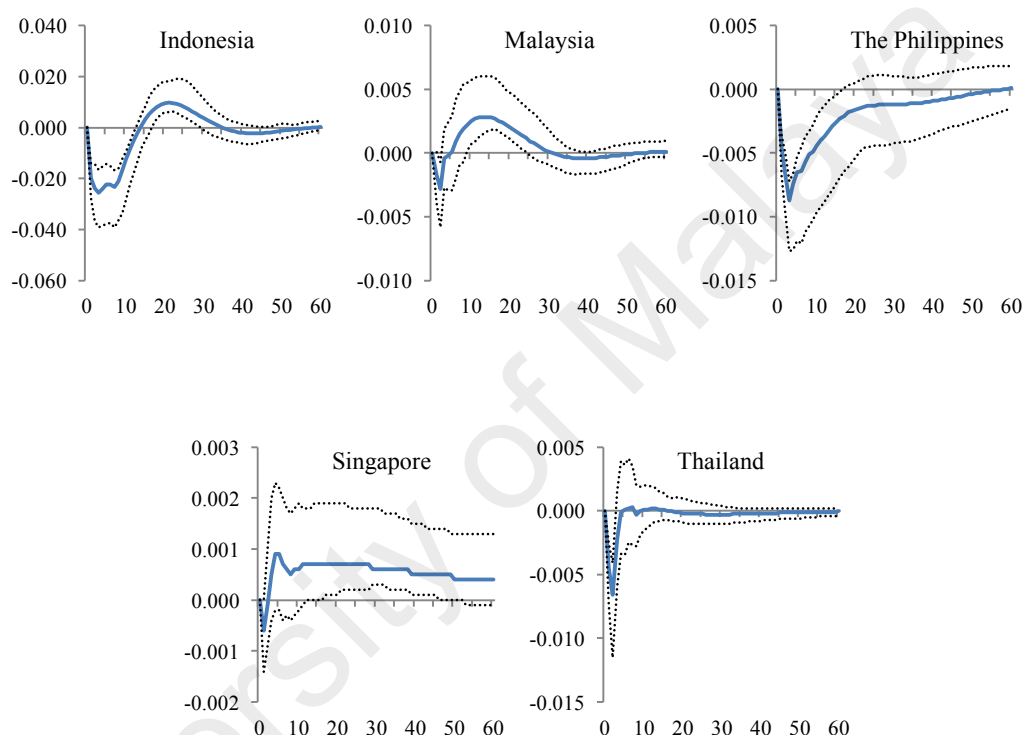
Source: Author's estimates

**Figure 5.3: Response of Real Credit to a Financial Stress Shock**

Figure 5.4 tries to provide some insight to how exchange rates tend to move when financial stress increases. The results display substantial cross-country heterogeneity. Exchange rate depreciation is observed in Indonesia, the Philippines and Thailand, albeit with differing time-dynamics. In Malaysia, there is initially a depreciating effect followed by temporary appreciation. The estimated effect for Singapore is both economically and statistically insignificant from 0.

The large variations in exchange rate responses across countries likely reflect differences in both institutions and policy regimes that are beyond the intended scope of this study. In Singapore, the NEER serves as the monetary policy instrument, indicating essentially that the Monetary Authority of Singapore's monetary policy stance does not systematically respond to changes in financial stress. In Malaysia, the central bank

intervenes to reduce exchange rate volatility. This may explain why the depreciation is temporary - for example, upon experiencing sudden capital outflows and exchange rate depreciation as financial stress increases, the central bank intervenes to limit the abrupt exchange rate depreciation and hence, reduces the overall exchange rate volatility associated with capital flow movements. Malaysia's exchange rate dynamics is likely also influenced by changes in the exchange rate regime during the sample period.



Source: Author's estimates

**Figure 5.4: Response of NEER to a Financial Stress Shock**

Overall, the impulse responses indicate that financial stress has negative effects on real economic activity. It, nonetheless, begs the question of its overall influence on economic activity. Financial shocks may have significant negative effects on domestic output, but explain only a small fraction of the total variation in output if they occur infrequently. The variance decomposition of IPI is analysed next to derive the contribution of financial stress to the real economy. The decomposition results at the 24- and 36-month horizons are presented in Table 5.4.

**Table 5.4: Decomposition of the Forecast Error Variance of Output (%)**

	GCP	IPI <sub>W</sub>	FSI <sub>US</sub>	IPI	CPI	IR	C	EX	FSI
24 months									
Indonesia	1	3	3	25	2	4	7	17	39
Malaysia	6	18	49	14	5	1	2	2	4
The Philippines	34	18	6	25	2	0	10	2	3
Singapore	5	39	24	28	0	0	1	1	1
Thailand	6	42	17	31	0	0	1	0	2
36 months									
Indonesia	1	4	3	23	2	4	13	16	35
Malaysia	4	25	49	10	4	0	1	2	3
The Philippines	37	14	13	18	1	0	8	4	4
Singapore	4	44	27	21	0	0	1	1	1
Thailand	5	52	16	23	0	0	2	0	1

Source: Author's estimates

As previously suggested, the contributions from domestic financial stress (FSI) to real economic activity (*IPI*) are relatively small. Aside from Indonesia as an outlier with the highest contribution of 39%, the contributions in the other four sample countries are below 5%. This indicates that, at least for the ASEAN-5 economies, financial stress events have historically been tail risks to the real economy, but such events have significant adverse effects when they occur. Meanwhile, a large amount of the variation in output can be attributed to external factors, which account for an average of 54% and 60% of the total variation in output at the 24- and 36-month horizons. The high external contributions validate the importance of including the foreign variables in VAR models when analysing open economies<sup>50</sup>.

<sup>50</sup> See Tng (2013) for an analysis of the impact of external shocks on output and inflation using a vastly similar SVAR model and sample.

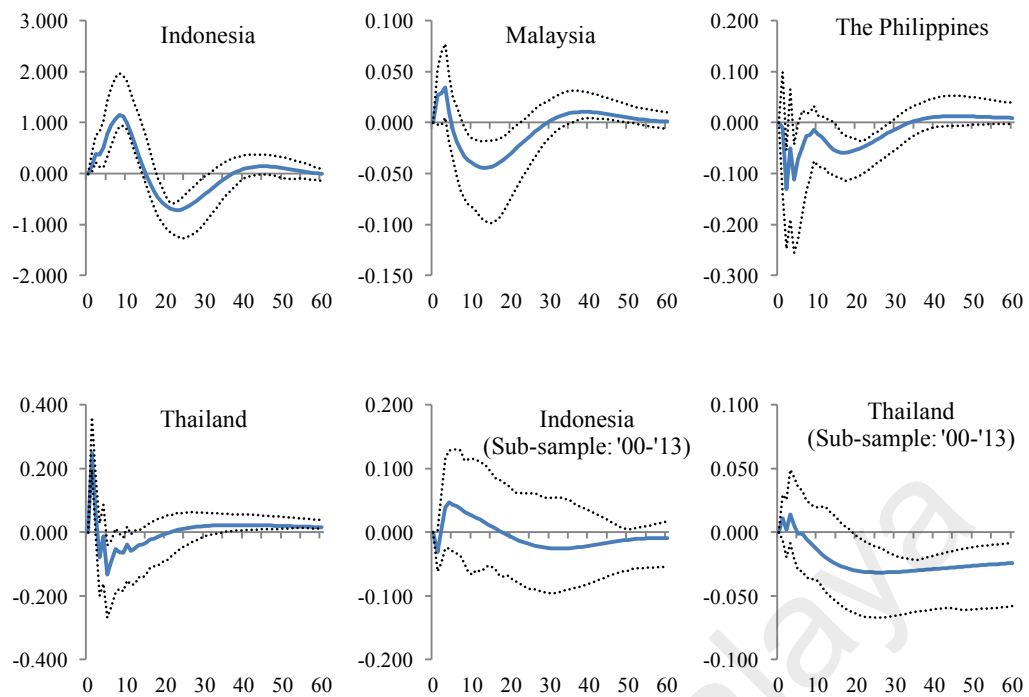
### 5.3.2 Monetary Policy under Financial Stress

Do ASEAN-5 central banks alter their monetary policy stance when financial stress increases? Is it effective? This section now explores the two-way interactions between monetary policy and financial stress. Singapore is excluded from this analysis because the exchange rate instead of an interest rate is used to conduct monetary policy. The result for Singapore is therefore not comparable with the other economies, due to differences in the policy instrument and identification of monetary policy shocks in the SVAR.

Figure 5.5 analyses monetary policy behaviour when financial stress increases, by illustrating the impulse responses of interest rates to a one standard deviation increase in financial stress. The impulse responses show that interest rates in Malaysia and the Philippines are lowered when financial stress increase<sup>51</sup>. Their interest rates decline the most during the first year after the financial shock. In Thailand, the interest rate displays an initial spike, followed by an easing trajectory similar to Malaysia and the Philippines. To see if the initial interest rate spike in Thailand's case is attributable to the brief period of high interest rate policy during the AFC, the impulse response function from the SVAR model estimated from 2000 onwards is also shown in Figure 5.5. The results show that removing the AFC period from the sample eliminates the initial spike in the interest rate, strongly suggesting that the spike is indeed a reflection of monetary policy tightening only during the AFC period. In Indonesia, the interest rate initially increases as well. Unlike Thailand, the initial increase in Indonesia's interest rate lasts for a longer duration and does not disappear when the AFC episode is removed from the sample. However, the magnitude of the increase becomes statistically insignificant from zero when the AFC episode is removed from the sample.

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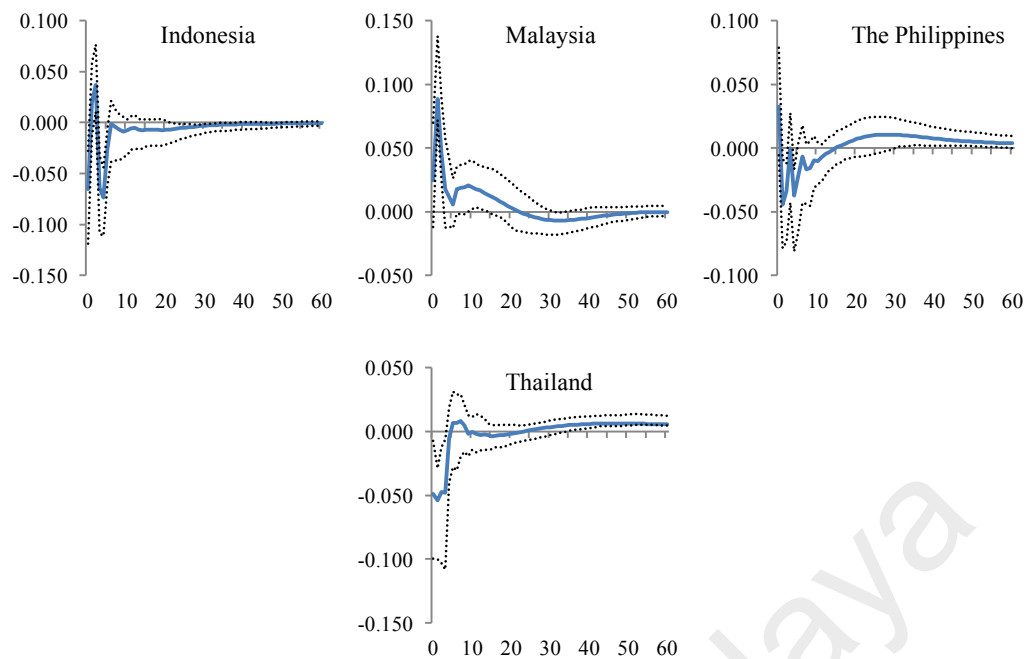
<sup>51</sup> The initial spike in Malaysia's case is small and statistically insignificant and is thus discounted for inference.



Source: Author's estimates

**Figure 5.5: Response of Interest Rate to a Financial Stress Shock**

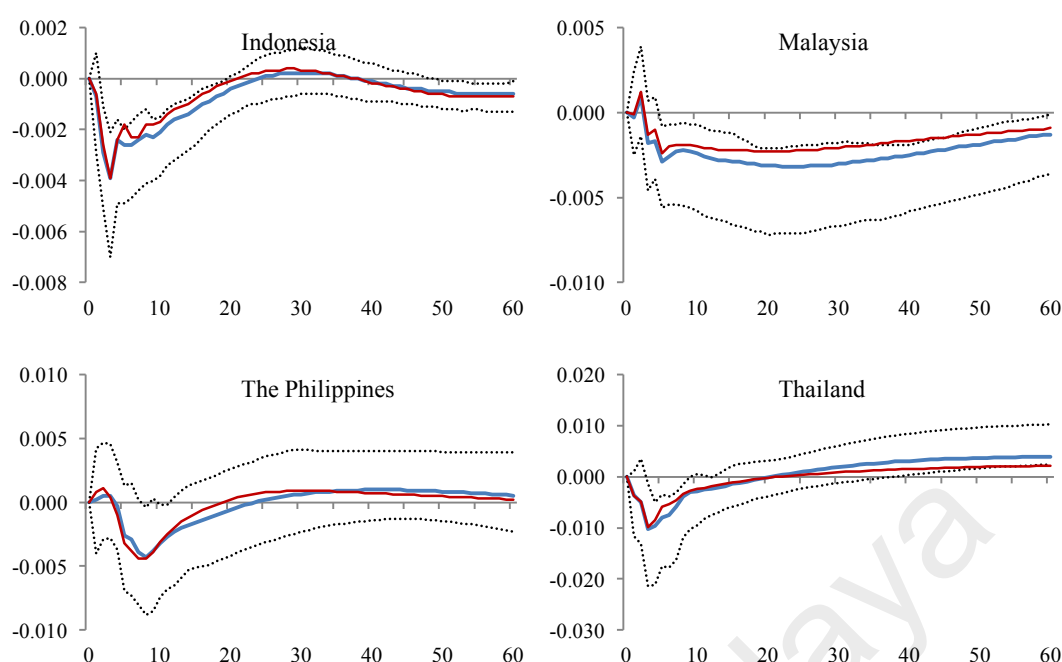
A natural follow-up question is whether monetary policy influences financial stress levels. Figure 5.6 gives an indication through the impulse responses of financial stress to interest rate shocks. The responses of financial stress are heterogeneous across countries, and are often small and statistically insignificant. This reflects a limit in the use of monetary policy to alleviate financial stress and that direct financial sector intervention is likely necessary to restore financial stability during crisis periods. This result, however, is not a justification against monetary policy easing during periods of higher financial stress. As shown earlier, higher financial stress adversely affects real economic activity and central banks may still use monetary policy to restore macroeconomic (output) stability. A key premise, however, is that lower interest rates are capable of stimulating output not by restoring financial stability, but through other channels.



Source: Author's estimates

**Figure 5.6: Response of Financial Stress to an Interest Rate Shock**

To give insight to this hypothesis, it is necessary to distinguish the effects of interest rates on output that is attributable to domestic financial stress as a transmission channel. This is achieved by comparing the impulse response functions from the baseline model to those from a restricted model. The restricted model is similar to the baseline model, except that domestic financial stress is exogenous. Doing so blocks off the responses of output to a change in the interest rate that passes through financial stress. The differences in impulse responses between the baseline and restricted SVARs reflect the degree of pass-through via domestic financial stress. This method of analysing the transmission channels of monetary policy follows from Morsink and Bayoumi (2001), Chow (2004) and Raghavan *et al.* (2012). To avoid specification issues due to well-known instabilities in the ASEAN economies' monetary policy reaction functions during the AFC period, the impulse responses for this analysis are estimated using data only from 2000 onwards. Figure 5.7 shows impulse responses of IPI to interest rate shocks from the baseline and restricted models.



Source: Author's estimates

Notes: The blue line and dotted lines are the responses and error bands from the baseline model. The red line is the response from the restricted model.

**Figure 5.7: Response of IPI to an Interest Rate Shock**

In all cases, the impulse responses from both models are largely similar and fall within the error bands from the baseline model. Thus, the analysis of monetary policy shows that although lowering interest rates generally have limited effects in restoring financial stability, such policy moves are effective in stimulating economic activity through other channels. Easing monetary policy amid financial episodes is therefore a desirable policy strategy to offset the contractionary effects of higher financial stress on output.

#### 5.4 Robustness

The assumptions made on the exogeneity of the domestic variables in the foreign equations are intuitive and common practice in existing literature. As small-open economies, it is reasonable to assume that they are affected by but cannot affect external developments. It also seems reasonable to assume that output and prices are affected by the financial variables in lags, given that changing them are often time-consuming activities and entail additional costs. But the ordering of the FSI variable within the

financial block is not as self-evident. Financial stress can have contemporaneous effects on the exchange rate since its value is partly determined by cross-border capital flows which can react quickly to changes in financial conditions. Monetary policy may also react contemporaneously to financial stress if central banks take it as a forward looking signal of macroeconomic prospects.

To test the sensitivity of the baseline findings, the SVAR models are estimated with alternative orderings of the FSI within the financial block and replicate the impulse responses from the main findings of this article - Figure 5.2 and Figure 5.7. The results are presented in Figure 5.8. The responses generated from alternative specifications are broadly in line with the baseline model. The impact of FSI shocks on IPI are broadly similar. The initial fall in IPI is steep, followed by a gradual tapering off. Similarly, the responses of IPI to interest rate shocks are robust to changes in the ordering of the FSI variable.

## **5.5 Conclusion**

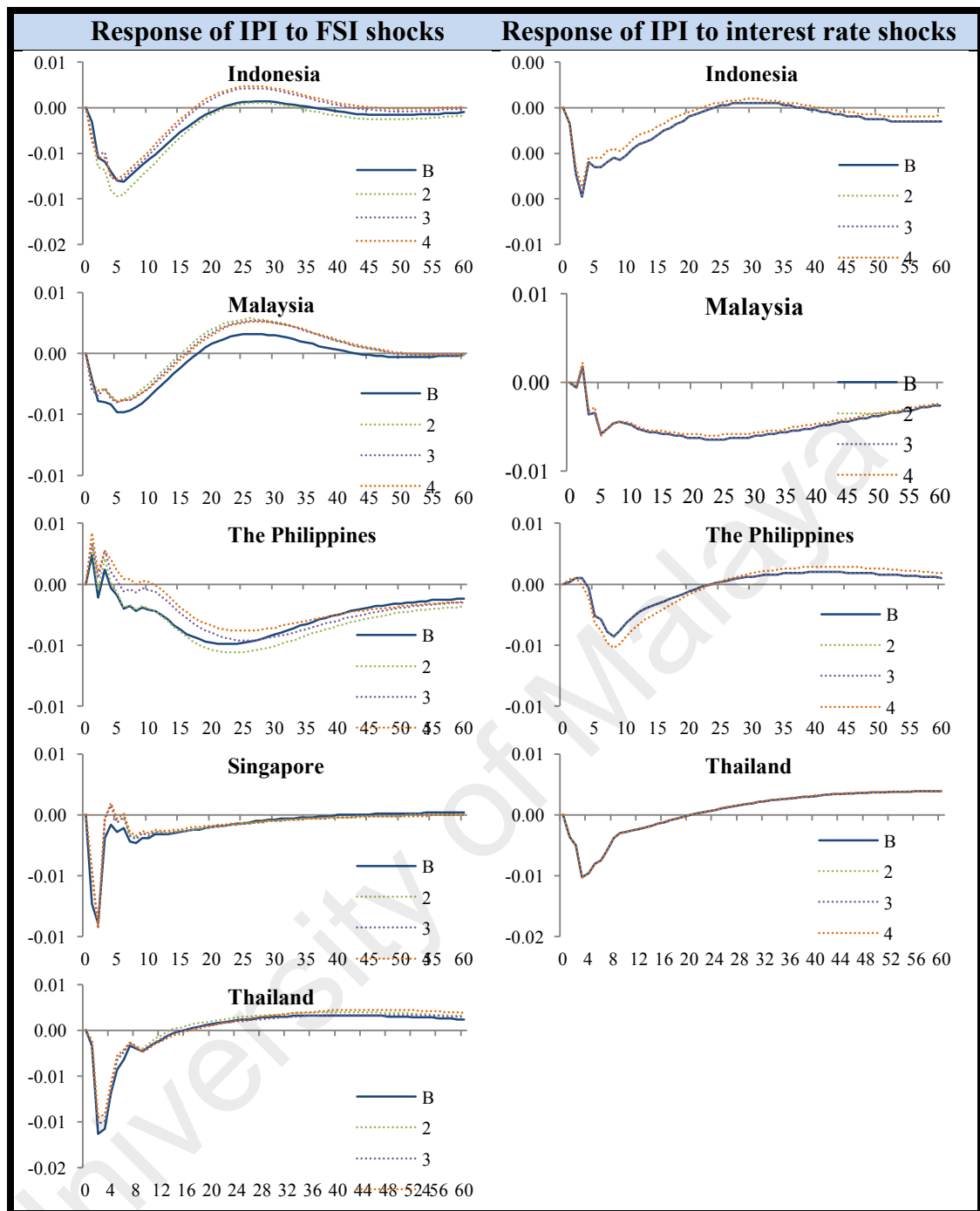
The goal of this chapter is to use a SVAR approach to contribute to the understanding of how financial stress affects the economy and monetary policy transmission. The estimations reveal that financial stress has negative effects on real economic activity, credit and, in some cases, the exchange rate. Although there is some heterogeneity in the responses, an empirical regularity in the responses of output is that the largest effects are felt within the first year of the shock. However, financial stress contributes a small share of the overall variation in output, which is likely attributable to the low frequency of high financial stress episodes.

The findings also show that central banks in Malaysia, Thailand and the Philippines tend to reduce their policy interest rates when financial stress increases. Although lowering



the policy interest rates have mixed results in reducing financial stress, they can still stimulate economic activity through other channels.

More generally, these findings suggest a necessity for monetary policy easing to help offset the contractionary effects of adverse financial shocks on the real economy. This helps central banks achieve their macroeconomic stability mandates. But monetary policy also needs to be complemented with direct financial sector interventions to restore financial stability. This may include, for instance, short-term loans to alleviate liquidity shortages, direct equity injections to financial institutions to reduce solvency risks and ensuring the sufficiency of trade credit to facilitate continued trade activities. In addition to a higher effectiveness to restore financial stability, another benefit of a targeted policy approach to restore financial stability is that it reduces time lag issues between the policies' effects on output and the effect that higher financial stress has on output. While there is potentially such a timing mismatch for monetary policy, policy instruments that directly restore financial stress to normal levels reduces this pitfall.



Source: Author's estimates

Note: B refers to impulse responses from the baseline model. 2, 3 and 4 are impulse responses from specifications with the FSI ordered respectively before the NEER, the NEER and real credit, and the NEER, real credit and the interest rate. Other assumptions remain similar to the baseline model.

**Figure 5.8: Impulse Responses from Alternative Ordering Assumptions**

## **CHAPTER 6 : CONCLUDING REMARKS**

### **6.1 Introduction**

The motivation of the study is to contribute to the field of financial crisis measurement, its sources, its effects on macroeconomic stability and how monetary policy effectiveness is affected during crisis periods. Before the GFC episode, there was no agreed on methodology to reflect the severity of financial crises as they unfold from the initial stages to when they becomes systemic events. There was also limited information on the dynamic effects of financial crises on real economic activity and guidance on the effectiveness of monetary policy during crises. Hence, as financial crises unfold and intensify, the forecast errors on growth become large. In addition, the monetary policy debate during crisis periods often reflect a lack of consensus over the best course of action.

The review of existing literature in Chapter 2 highlights that these analytical shortcomings are attributable in large part to the state of progression in the relevant lines of literature. Especially before the GFC, there was no available measure of financial stability beyond the binary financial crisis indicator - crisis or no crisis. It was hence difficult to track the unfolding of financial crises in real time or analyse how changes in financial stability conditions affected macroeconomic conditions and monetary policy transmission. This study seeks to address some of these limitations and contribute to the current knowledge.

The analysis in this study focused on the following three areas. First, in Chapter 3, a methodology was developed to measure financial stability conditions on a continuous scale through the construction of Financial Stress Indices (FSIs). Second, in Chapter 4, using the FSIs from Chapter 3, a panel model of financial stress was developed to determine the sources of financial stress throughout the entire financial cycle, instead of

just financial crisis periods. Third, in Chapter 5, a Structural Vector Autoregression (SVAR) model is developed and estimated to give insight to how adverse financial shocks are transmitted to the real economy and how monetary policy transmission is affected by financial stress.

The analysis is conducted using data from the ASEAN-5 economies of Indonesia, Malaysia, the Philippines, Singapore and Thailand over the period ranging from 1997-2013. The reason for this choice of economies is that post-GFC, a majority of the analyses in broadly similar areas were concerned about the US economy and the Euro Area economies, where the epicentre of the crisis was. In addition to being a relatively unused sample in this emerging literature, as small-open economies, using the ASEAN-5 economies as the sample also poses unique modelling challenges that differ from large, developed economies.

The remaining chapter proceeds as follows: Section 6.2 presents summaries of the findings and main contributions made to existing literature. Section 6.3 discusses the practical implications of the study's findings. The last section discusses opportunities for further research.

## **6.2 Main Contributions and Findings**

In Chapter 3, Financial Stress Indices (FSIs) are constructed for the ASEAN-5 economies. These indices measure financial stress in individual asset markets and at the overall systemic level. In contrast with existing ASEAN-5 FSIs, the FSIs constructed here incorporate stress in the domestic bond market, in addition to the usual equity market, foreign exchange market and banking sector. In addition, the weights that are used to aggregate the market specific indicators of financial stress to form the overall FSI reflect the financial structure of the economy. Hence, markets that provide a large share of financing to economic agents are assigned proportionately large weights. The FSIs are

then used to chronicle financial episodes among the ASEAN-5 from 1997-2013. This is done for the individual countries as well as from a regional perspective, by documenting the clustering of local and global peaks in the FSIs over time. Three notable financial episodes stand out - the Asian Financial Crisis (AFC) in 1997-1998, the technology bubble burst (tech bust) in 2000-2001 and the GFC of 2007-2009. The AFC ranks as the most severe financial episode. Financial stress was the highest in levels and lasted the longest. This is not surprising as this episode originated regionally and domestically in many cases. In addition, the FSIs indicate that the tech bust was a more severe financial episode compared to the GFC for the ASEAN-5 economies, except for Singapore. The latter finding is perhaps surprising, as the GFC was a substantially more severe financial episode regardless of whether the episodes are considered from a global perspective or solely from the origin of the crisis.

In Chapter 4, the ASEAN-5 FSIs from Chapter 3 are used to estimate a panel model of financial stress that incorporates global, regional and domestic factors. Four main contributions are made in this Chapter. First, ASEAN-5 regional contagion is measured more rigorously compared to existing studies in the FSI literature. Taking guidance from the financial contagion literature, financial contagion is measured first by stripping the ASEAN-5 FSIs of the fundamentals based variations, then using principal component analysis to identify the common variation in the “non-fundamental” portion of the movements in the FSIs. Second, an Instrumental Variable (IV) approach is taken to control for two-way causality between financial stress and its domestic-based determinants. Third, the FSIs are utilised to investigate the role of trade and financial linkages in facilitating the transmission of financial stress from external to ASEAN-5 financial markets. Finally, the panel analysis is conducted on the market specific-FSIs to analyse whether the determinants are similar across asset markets and to give insight to how financial stress spreads across asset markets. The results show that of the

external/common variables considered, US financial stress and regional contagion are consistently statistically significant across specifications and methodology. Of the domestic variables, only bank credit emerges as significant, with a positive bank credit gap foreshadowing higher financial stress. Panel analysis of the sources of financial stress within individual asset markets reveals the importance of the banking system and equity markets for financial stress elsewhere. Of significance, there is a vicious cycle of stress transmission between the banking system and equity market - higher stress in either market elevates stress levels in the other, which in turn worsens the originating source of stress, and so on.

In Chapter 5, the ASEAN-5 FSIs from Chapter 3 are used to estimate Structural Vector Autoregression (SVAR) models for each sample country. In contrast with existing VAR-based studies with FSIs that tend to focus on large developed economies, the sample in this study comprise of small-open economies. The small-open economy assumption is reflected explicitly in the SVAR's structure, where the global variables can affect the domestic variables, but not vice versa. Four questions are posed: First, what is the impact of financial stress on real economic activity? Here, the time dynamics and transmission are analysed. Second, does monetary policy respond systematically to financial stress? Third, is monetary policy effective in alleviating financial stress? Finally, do changes in financial stress alter the transmission of monetary policy to the real economy? The last two questions, in particular, give insight to the ongoing debate on whether monetary policy was effective in aiding the economic recovery from the GFC period. The findings show that higher financial stress leads to lower credit and real economic activity. The estimated time dynamics for the impact of higher financial stress on the real economy are an initial rapid decline, followed by a gradual dissipation. In Malaysia, the Philippines and Thailand, the central banks tend to reduce their policy rates when financial stress increases, although the impulse response analysis reveal substantial cross-country

variation in the magnitude and time dynamics. Finally, lower policy interest rates are found to have limited significant effects in lowering financial stress, but are still effective in stimulating economic activity through other channels.

### **6.3 Practical Implications**

There is a myriad of inter-linkages between financial markets and the real economy. A stable and well-functioning financial system is necessary to sustain growth in the real economy along a path that is both high and stable. As the GFC episode forcefully demonstrated, episodes of financial instability can have long-lasting effects on the real economy and labour markets. Yet, measures of financial stability and their incorporation in mainstream macro models that are commonly used for forecasting and monetary policy analysis were missing, especially pre-GFC. In this context, this study aimed to improve the surveillance of financial stability conditions through the construction of financial stress indices, to analyse what drives changes in financial stability, how they affect growth and how monetary policy transmission is affected by changes in financial stability.

#### **6.3.1 Improving the Communication of Financial Stress**

The FSIs constructed in this study can be updated monthly with relative ease and low lag. They can thus be added to the set of indicators that are monitored on an ongoing basis for macro-level financial market and monetary conditions. This applies to both the market-specific and overall FSIs. The analysis of the sources of financial stress in small-open economies reveals that external and regional financial conditions as well as domestic credit are significant drivers. This implies that these indicators should also be added to the set of indicators for monitoring financial conditions.

Uncertainty is often heightened during periods of financial crises. The uncertainty effect alone leads economic agents to hold off on planned expenditures until the uncertainty subsides. This is true even for financially viable firms and households (Bloom, 2009;

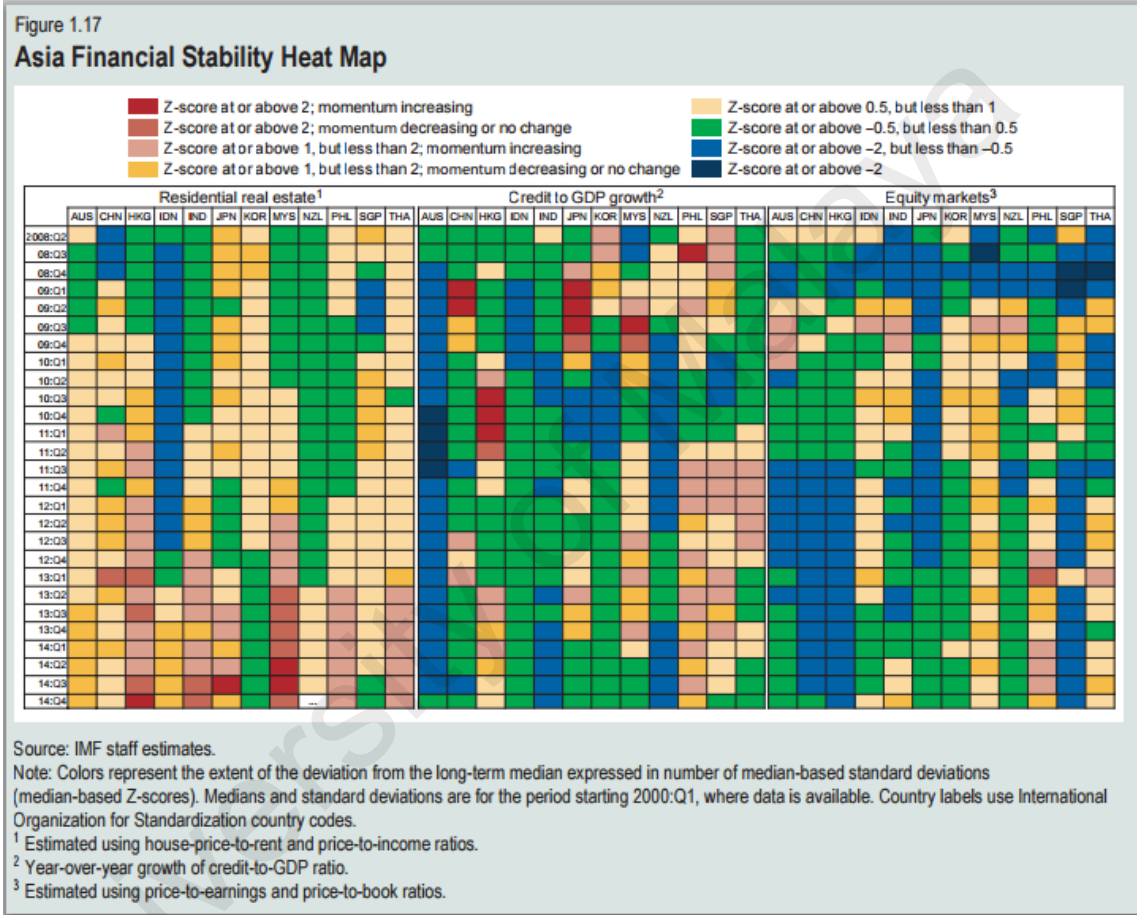
Bloom, Bond & Van Reenen, 2007; Carrière-Swallow & Céspedes, 2013). In this regard, effective communication becomes a key aspect of financial crisis management. This includes communication over the severity of crises, its effects and the policy steps that are being undertaken to address the adverse effects. An advantage of the FSIs developed in this study is that they are easy to interpret - higher values reflect higher stress. The FSIs can thus be used as an effective tool to communicate the state of the financial crisis to the public.

As a complement to using the overall and market specific FSIs to communicate the stage of the financial crisis, “heat maps” can be utilised to illustrate vulnerabilities arising from the individual variables that drive financial stress, as found in chapter 4. Heat maps illustrate graphically the build-up of financial stability risks based on the performance of these indicators. Figure 6.1 illustrates a recent example of a heat map that was recently applied by the IMF to assess and illustrate financial stability risks in Asian economies. The top of the x-axis lists three indicators of focus: residential real estate prices, credit-to-GDP growth and equity prices, which have been standardised and represented as  $z$ -scores. The Y-axis illustrates time, while the colours reflect different levels of financial stability risks through different colours that represent varying  $z$ -scores over time and across indicators. Black represents the lowest level of risk while red represents the highest level of risk.

In the context of this study’s findings, heat maps can be applied in two ways. First, it can reflect market-specific levels of financial stress using the market specific FSIs, and overall systemic levels of financial stress using the overall FSIs that were constructed in chapter 3. The colour codes can be similar with the example in Figure 6.1. Low levels, reflecting low stress, may be illustrated using black colour. As stress levels gradually increase, the colours turn blue, yellow, orange and eventually red, which represents a



systemic financial crisis. The second possible application of the heat map pertains to the sources of financial stress that were found to be statistically significant determinants in chapter 4. Of note, for small and open economies such as the ASEAN-5 economies, is the need to include global financial stress and regional financial contagion levels, in addition to the traditional domestic variables such as the output gap and domestic credit measures.



Source: IMF Regional Economic Outlook (Asia and the Pacific) 2015

**Figure 6.1: Sample Heat Map Applied to Asian Economies**

### 6.3.2 Reducing Forecast Errors of Economic Activity and Quicker Policy Responses

A key benefit of integrating the set of FSIs and related indicators to the surveillance toolkit at central banks is that it helps to improve predictions about the future direction of real economic activity, since as Chapter 5 shows, shocks to financial stress affect the real

economy. This is important as the improvement in forecast capability brought forth by integrating financial stress into a standard macro model allows for quicker and more decisive policy responses. Chapter 5 provides empirical evidence that monetary policy is still effective during periods of higher financial stress, and should thus be used to offset the contractionary effect of higher financial stress on the real economy.

From a broader perspective, these findings imply that monetary policy easing is a necessary but likely an insufficient policy response during episodes of higher financial stress. This is because although monetary policy easing offsets the contractionary impact of the adverse financial shocks on the real economy, it does not aid to restore financial stability to normal levels, which is the root cause of the economic downturn. Monetary policy easing should thus comprise of part of a broader policy response that includes measures that are targeted directly at improving financial conditions. This includes, for instance, providing short-term loans to alleviate liquidity shortages, equity injections to ailing financial institutions to reduce solvency concerns and ensuring the continued flow of credit to credit-worthy households and firms and the sufficiency of trade credit to facilitate continued trade activities. In addition to achieving a higher effectiveness in restoring financial stability, another benefit of policies that are targeted at reducing financial stress levels is that they avoid timing mismatch issues that arise due to the different time dynamics between the effects of financial stress on the real economy and the effects of monetary policy easing on the real economy. Notably, the former effects grow much quicker compared to the later.

### **6.3.3 Combining Micro-Level Supervision with Macro-Level Surveillance**

The market specific and overall FSIs facilitate ease in communicating the level of financial stress from a macro-level. In addition, it is necessary to understand the sources of financial stress at the micro level, from individual institutions and investors, beyond what the macro-level data reflects.

Recognising the importance of micro-level information gathering, the Bank of England recently institutionalised this aspect of surveillance through the “Market Intelligence Charter”. This form of information gathering is regarded by the Bank of England as:

*“Providing the Bank with crucial insights beyond publically available data, which are essential in helping to identify actual and incipient sources of monetary and financial instability.”* (Bank of England, 2015)

While it is likely that many central banks already do engage individual financial market participants to seek their views and to provide a micro-level context of macro-level data, few have institutionalised and explicitly recognised this aspect to aid their communication and the policy decision making process.

#### **6.3.4 Need for Increased Corporation among Regional Central Banks and Supervision Authorities**

The significant role of regional financial contagion revealed in chapter 4 suggests that the cumulative stability of the region’s financial markets is an important pre-condition for the stability of individual financial markets within the region. During the Asian Financial Crisis (AFC), regional level contagion spiked and exacerbated financial stress among all the ASEAN-5 economies. In contrast, regional contagion levels remained low during the tech bust (2001-2002) and GFC (2007-2009), which is a key reason ASEAN-5 financial stress remained low, especially during the GFC. Overall, this raises the importance of corporation and policy coordination amongst the regional central banks and regulators, and suggests that there are benefits to incorporating a multilateral dimension in policy formulation and financial market surveillance for the ASEAN regional economies. Preserving financial stability at the regional level is complementary to efforts to preserving financial stability at the national level.

#### 6.4 Further Research Opportunities

This study contributes to a relatively young but rapidly developing literature of constructing indices that reflect systemic financial conditions in high frequency (at least monthly), analysing how such indices behave and how best to integrate them into mainstream models for macroeconomic and policy analysis. There are certainly further research opportunities going forward.

The sample coverage in this study comprises of the ASEAN-5 economies over the period 1997-2013. This sample includes a variation of financial stress episodes that originate from domestic, regional and global sources. There are, nonetheless, additional benefits from further expanding the sample period, especially backwards, to incorporate additional global and domestic episodes in the 1980s and early 1990s. Achieving this in this study was constrained by limited data given the methodology used to construct the FSIs. While the data that was needed to construct certain indicators was not available, a potentially fruitful way forward would be to develop a methodology, which allows the flexibility of including and excluding variables from the indices over time. This is done by Hatzius *et al.* (2010) in their construction of Financial Conditions Indices (FCIs) for the US economy. The weighting methodology used in this case is based on factor analysis, which allows for the inclusion/exclusion of variables over time.

The estimation results for the sources of financial stress in chapter 4 will be more robust with a longer sample, at least for the case of the ASEAN-5 economies. A result of the panel methodology is that the estimated parameters are constant for all the countries, which can be perceived as a strict assumption. This study was constrained to a panel methodology by the rather limited number of observations especially for the instrumental variable estimations. With a longer time series, moving from a single panel model to country specific models will allow cross country variation in the parameters, which serves as a useful robustness check of the panel estimation results. In addition to a longer sample

period, there are also benefits to increasing the number of countries. This will ensure that the empirical findings are generalizable to other countries instead of just the ASEAN-5 economies.

Another potential area for improvement in the methodology in chapter 4 concerns the estimation of the regional contagion variable. This study constructs the variable in two steps. An alternative modelling strategy is to perform the analysis in one step by estimating the baseline model while treating contagion as a latent variable, either by modelling it as part of the disturbance term, which imposes a specific heteroskedastic structure on the overall disturbance term, or by treating the model as a kalman filter with contagion as the unobserved variable. Furthermore, financial contagion tends to occur at high frequencies. To incorporate this variable at higher frequency compared to the other variables, the baseline model can be specified and estimated using a Mixed Data Sampling (MIDAS) regression approach.

In chapter 5, a natural extension of the SVAR model is to incorporate the possibility of non-linear relationships in the form of thresholds. Specifically, allowing for a threshold effect between low stress and high stress states (i.e. using the financial stress variable as a source of non-linearity in the macro model), as is done by Davig and Hakkio (2010) and Hollo et al. (2012) using more simplistic models. Another plausible area of inquiry is motivated by the fact that the impulse responses from the SVAR models reflect substantial cross-country variability in both the magnitude and time dynamics. While it is outside the intended scope of this study, it would be beneficial to delve deeper into the economic reasons for these variations and the implications. Giving more specific reasoning to the differing responses of industrial production to financial stress shocks across countries likely requires further detailed country level analysis of the structure of these economies and their financial systems. Another possible approach is to conduct

similar SVAR estimations for a larger number of economies, document the corresponding responses, and then see if they vary systematically according to plausible indicators such as financial market development and policy credibility.

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## PUBLICATIONS, PAPERS PRESENTED AND AWARDS

### Journal Publications

- Tng, B. H., & Kwek, K. T. (2015). Financial Stress, Economic Activity and Monetary Policy in the ASEAN-5 economies. *Applied Economics*, 1-17.
- Tng, B. H., Kwek, K. T., & Sheng, A. (2012). Financial Stress in ASEAN-5 Economies from the Asian Crisis to the Global Crisis. *The Singapore Economic Review*, 57(02), 1250013.

### Working Papers

- Tng, B. H. (2015). The Transmission of Financial Stress and its Interactions with Monetary Policy Responses in the ASEAN-5 Economies. *Bank Negara Malaysia Working Paper Series, WP6/2015*.
- Tng, B. H. (2013). External Risks and Macro-Financial Linkages in the ASEAN-5 Economies. *Bank Negara Malaysia Working Paper Series, WP1/2013*.

### Papers Presented

“The Transmission of Financial Stress and its Interactions with Monetary Policy Responses in the ASEAN-5 Economies” was presented at the:

1. 2014 Joint Meetings of the Australian Conference of Economists and Econometric Society Australasian Meetings (ESAM) in Tasmania, Australia;
2. 2014 ISI Regional Statistics Conference in Kuala Lumpur, Malaysia, and;
3. Bank of Thailand and Bank for International Settlements (BoT-BIS) 8<sup>th</sup> Annual Workshop of the Asian Research Networks 2015.

## **Award**

The “Young Malaysian Researcher Prize 2016” was awarded by the World Bank Development Research Group for the paper “The Transmission of Financial Stress and its Interactions with Monetary Policy Responses in the ASEAN-5 Economies”. The following are links to the public announcements:

<http://www.worldbank.org/en/news/press-release/2016/03/28/world-bank-office-opening-highlights-malaysias-development-experience>

[http://www.worldbank.org/en/news/speech/2016/05/27/young-malaysian-researcher-on-preventing-financial-crises?cid=EAP\\_E\\_MalaysiaeAlert\\_EN\\_EXT](http://www.worldbank.org/en/news/speech/2016/05/27/young-malaysian-researcher-on-preventing-financial-crises?cid=EAP_E_MalaysiaeAlert_EN_EXT)